Appendix H.5

BATS ASSESSMENT

Public

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PhD Zoology
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Final Report: Impact Assessment Report for Bats on the Proposed Dalmanutha Wind Energy Facility (Alternative 1 and 2) near Belfast in Mpumalanga, South Africa

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Author	Qualification	SACNASP	Role in project
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EXPERTISE OF BAT SPECIALIST

Low de Vries is a registered bat assessment specialist with SABAA and has consulted for numerous field projects, which included bird surveys and the removal of dangerous snakes in Mozambique, as well as several biodiversity surveys in South Africa. He obtained a PhD in Zoology while investigating the general ecology of aardwolves with special focus on home range, diet, and prey abundance. After his PhD he spent 14 months on Marion Island assisting with field work on elephant seals, fur seals and killer whales. During his subsequent postdoctoral position at the University of Pretoria he spent six years conducting research on the ecology of bats and has obtained extensive knowledge on bat behaviour and movements, as well as experience in bat handling.

Disclaimer by specialist

I declare that the work presented in this report is my own and has not been influenced in any way by the developer. At no point has the developer asked me as specialist to manipulate the results in order to make it more favourable for the proposed development. I consider myself bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP) and the EIA Regulations (2014, as amended). I have the necessary qualifications and expertise (*Pr. Sci. Nat. Zoological Science)* in conducting this specialist report.

Low de Vries, PhD Zoology, *Pr. Sci. Nat. Zoological Science*

ACRONYMS & GLOSSARY OF TERMS

AOI: Area of Influence, the area that is affected by the proposed development.
Acoustic monitoring: Recording and analyses of echolocation calls to determine bat community species composition and abundance.
ACR: African Chiropteran Report.
AOI: Area of Influence, the area that is affected by potential impacts.
Bat call: An echolocation call emitted by a bat used to detect prey and navigate through its surroundings.
Bat detector: Electronic device for the detection and recording of bat echolocation calls. The terms Bat Detector and Song Meter are used interchangeably in this report.
Bat roost: A structure, natural or man-made, were bats roost during the day. This includes caves, trees, rocky outcrops, buildings, and culverts.
Blade tip sweep height: Height between ground level and the lowest point of the wind turbine rotor sweep zone.
bp/h: Bat passes per hour, calculated as a mean or median value from the nightly average bat passes per hour.
Buffer zone: A zone established around areas that are identified as sensitive for bats and includes flyways, foraging areas and bat roosts.
CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora.
Cumulative Impact: Impacts created due to past, present, and future activities and impacts associated with these activities.
Echolocation: A physiological process for locating distant or invisible objects (such as prey) by means of sound waves reflected to the emitter (such as a bat) by the objects.
EMPr: Environmental Management Programme: A legally binding working document, which stipulates environmental and socio-economic mitigation measures which must be implemented by several responsible parties throughout the duration of the proposed project.
Endemic: A species that is restricted to a particular area.
EIA (Environmental Impact Assessment): The process of identifying environmental impacts due to activities and assessing and reporting these impacts.
GPS: Global Positioning System device.
IUCN: International Union for Conservation of Nature.
MW: Megawatts.
NEMA: National Environmental Management Act.
Pre-construction phase: The period prior to the construction of a wind energy facility.
Pulse: A single emission of sound by a bat.

Red data species: Species included in the Critically Endangered, Endangered, Vulnerable or Rare categories as defined by the IUCN.
REDZ (Renewable Energy Development Zones): Areas were wind and solar photovoltaic power development can occur in concentrated zones.
Rotor blades: The air foil of a wind turbine that catches the wind and rotates.
Rotor swept area: The area through which rotor blades of a wind turbine rotate.
S&EIA: Social and Environmental Impact Assessment (EIA): The process of identifying social and environmental impacts due to activities and assessing and reporting these impacts.
SABAA: South African Bat Assessment Association.
SABPG: South African Best Practice Guidelines for Pre-construction Monitoring of Bats at Wind Energy Facilities
SACNASP: South African Council for Natural Scientific Professions.
SANBI: South African National Biodiversity Institute.
Scoping Report: A report contemplated in regulation 21 of the NEMA amended EIA regulations R326 dated 7 April 2017.
Song meters: A particular brand of Bat Detector developed by Wildlife Acoustics. The terms Song Meter and Bat Detector are used interchangeably in this report.
SD card: A storage device for song meter recordings.
ToPS: Threatened or Protected Species.
DAL 1 – DAL 7: Names of bat detectors
Turbine: A device that harnesses wind energy and turns it into kinetic energy used for the generation of electricity.
WEF: Wind Energy Facility.

1. Introduction

1.1 Project details

Volant Environmental (Pty) Ltd was commissioned by Dalmanutha Wind (Pty) Ltd to conduct a 12-month Pre-Construction Survey for bats on a proposed Wind Energy Facility (WEF) which will be known as Dalmanutha WEF, and for the associated infrastructure. Currently two alternative facility descriptions have been provided for consideration by specialists. Alternative 1 will be developed with a capacity of up to 300 megawatts (MW) that will comprise solely of wind energy with a projected turbine number of 70. Alternative 2 will have a generating capacity of up to 300 megawatts (MW) that will comprise of wind energy (44 turbines) as well as Solar Energy Facilities (SEF). Turbines will have a hub height of 200 m and rotor diameter of 200 m. The most feasible option will be recommended based on the specialist input described in this report. This survey serves as a Pre-Construction Assessment of the bat activity and bat species present in the Project Area of Influence (PAOI) of the proposed WEF.

1.2 Project location and ecoregion

The proposed WEF is located approximately 7 km Southeast of Belfast (Figure 1), within the Emakhazeni Local Municipality, in the Mpumalanga Province. Belfast is known for its excellent trout fishing conditions as well as an abundance of sheep, dairy, maize, potatoes, and timber farming. The proposed WEF can be accessed off the N4 that runs North of the proposed project area. The total PAOI (AOI = WEF boundary) covers an area of *ca* 9 197 ha and is mainly used as agricultural land with livestock present across a large section of the AOI.

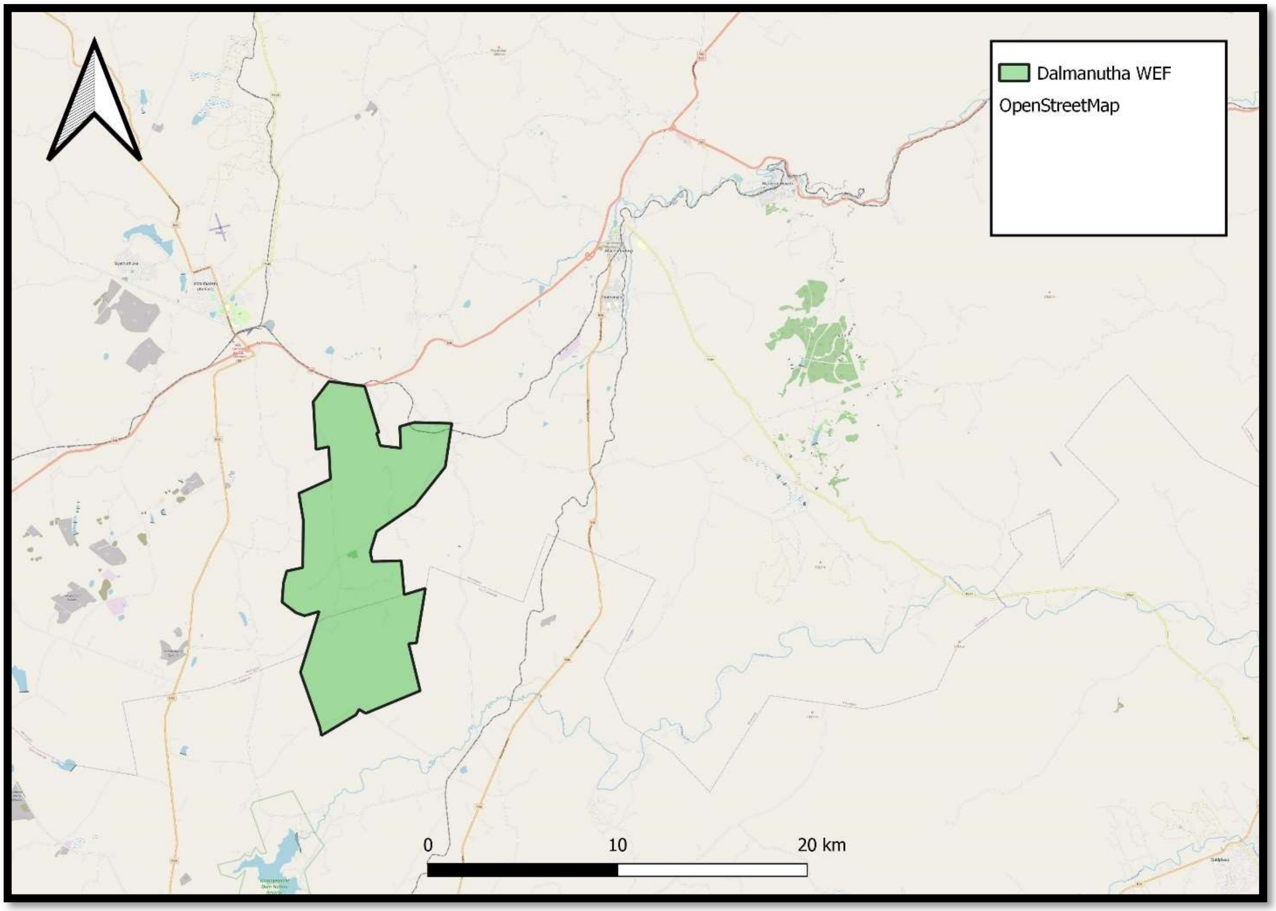


Figure 1. Location of the proposed Dalmanutha Wind Energy Facility

The proposed PAOI falls across the Grassland Bioregion with the majority of the PAOI consisting Eastern Highveld Grassland with pockets of Steenkampsberg Montane Grassland and KaNgwane Montane Grassland vegetation types present on the proposed development site (Figure 2, SANBI 2018). Based on the South African Best Practice Guidelines for Pre-Construction Monitoring of Bats at Wind Energy Facilities (SABPG, MacEwan *et al*., 2020) this is classified as the Grassland biome, and all future fatality risks for Pre-Construction monitoring will be assessed based on this ecoregion.

The extent of the Grassland Biome is relatively well defined on the basis of the specific known vegetation structure when seen in combination with the amount of rainfall in the summer and the

average minimum temperatures in the winter. This biome occurs mainly on the high central plateau (Highveld), as well as the inland areas of the eastern seaboard and the established mountainous areas of KwaZulu-Natal and Eastern Cape. The biome is primarily characterised as flat to rolling, but also includes mountainous regions and escarpments. The effect of this biome being at a higher altitude result in larger temperature differences at different times of the year. The climate in winter months specifically, can be cold and dry with the occurrence and relative high frequency of frost. The presence of high amounts of moisture allows for grassland regions to be divided into two classes. Moist grassland primarily consists of sour grasses, leached and dystrophic soils and high canopy cover, high plant production and high fire frequency. Dry grasslands are seen as sweet, palatable grasses, where the soils are less leached and are eutrophic and canopy cover, plant production and fire frequency are lower than in moist grasslands. Grasslands are structurally simple and strongly dominated by grasses (*Poaceae*). It is noted that the moisture index affects canopy cover and decreases with lower mean annual rainfall but is influenced by the amount and type of grazing and by the presence of fire. This in turn allows for woody species to occur but are limited to specialised niches/habitats within the grassland biome.
The Eastern Highveld Grassland is primarily known for its slightly to moderately undulating plains, that include some well-defined low hills and pan depressions. The vegetation in this biome is short dense grassland dominated by the usual highveld grass composition. Small, scattered rocky outcrops with wiry, sour grasses are also found within this vegetation. The Steenkampsberg Montane Grassland is also characterised by slightly to moderately undulating plains, that include some well-defined low hills and is dominated by highveld grass composition with small, scattered rocky patches found throughout. KaNgwane Montane Grassland pockets seen on the outskirts of the PAOI, are largely comprised of undulating hills and plains that occur on the eastern edge of the Escarpment found within this region. The vegetation structure is comprised of a short grassland layer with many forbs, and a few scattered shrubs on the rocky outcrops (Mucina and Rutherford, 2006).

The warmest month (with the highest average high temperature) is December (29.86 C) while the coldest month (with the lowest average low temperature) is June (9.0 C). The area receives an average of 181.1 mm of rain during January, which is the wettest month of the year.

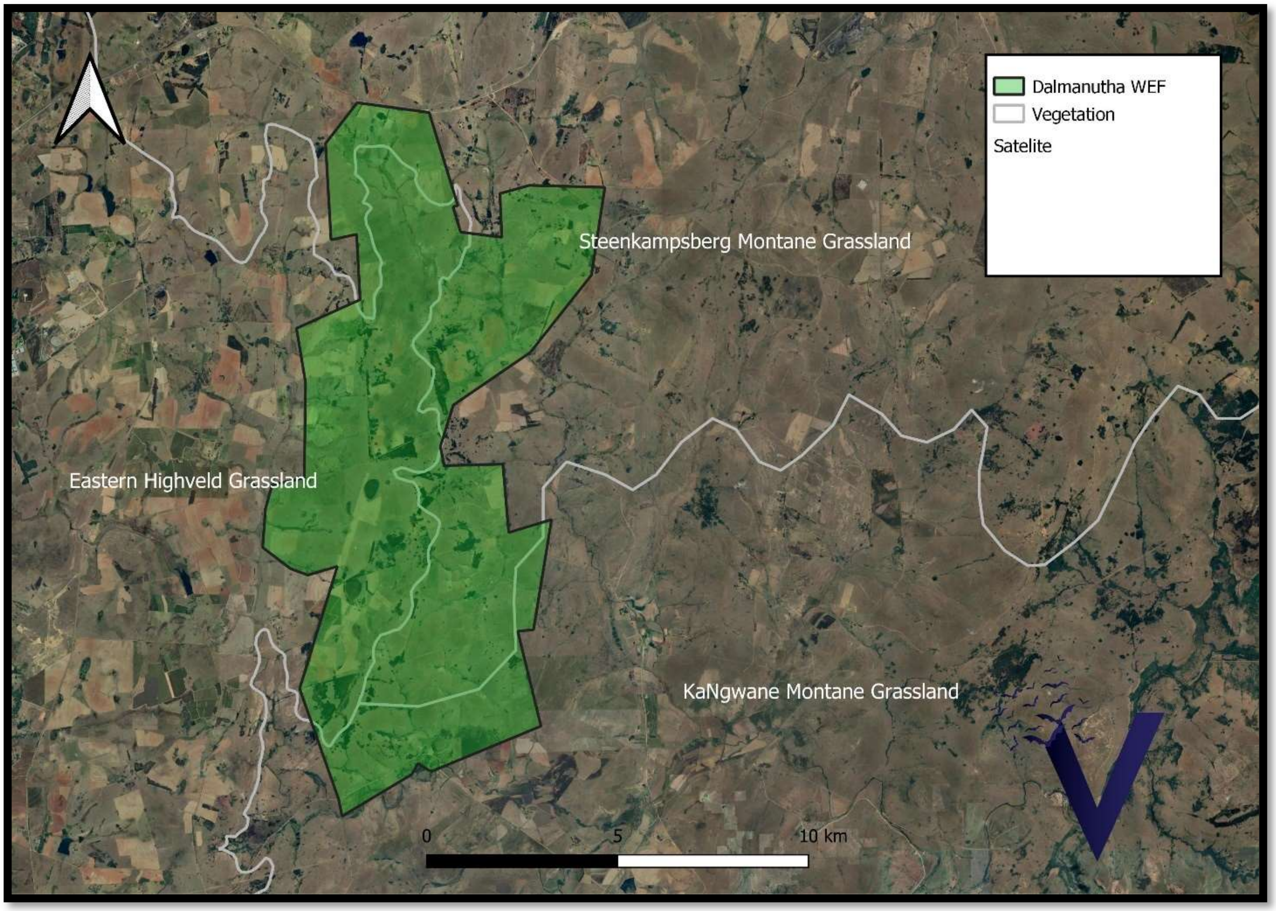


Figure 2. Representation of ecoregions found on the Proposed Area of Influence

Figure 3. Photographic representation of habitat

1.3 Bat validity period

The current survey results are representative of the full 12-months of the survey period. Bats are known to migrate before winter periods or annually to maternity roosts (Jacobsen and du Plessis, 1976), and as such the species assemblages for the area could potentially be different during different years. The data collected during this survey period should, however, be a good representation for similar seasons of different years and should be applicable for a five-year period.

1.4 Assumptions and Limitations

Distribution records of bats in southern Africa are still poorly reported and limited for many species. In addition, migratory patterns of bats are largely unknown in South Africa. Studies have reported that bats do migrate, but the exact routes followed are not known (Pretorius *et al.*, 2020). The same is true for breeding behaviour and the formation of maternity colonies for many species. WEF pre-construction monitoring reports on bats are reliant on reporting echolocation calls and identifying species from these calls, but without echolocation call libraries accurate identification is not always possible. Published libraries created from release and handheld calls of captured bats are available for southern Africa but are geographically limited. Since the echolocation calls of a particular species from different regions in South Africa are known to vary to some degree (Monadjem *et al.*, 2020), call libraries created in different regions are not always comparable.
Bat detectors are not always effective in recording echolocation calls for all bat species, and some species may be missed e.g., some fruit bat species that do not echolocate. Other species, such as the Egyptian slit-faced bat (*Nycteris thebaica*), emits low intensity calls that may not be recorded. Bat detectors are also limited in the range over which a call can be recorded, and this can be further influenced by environmental conditions such as humidity. In addition, the microphones that are coupled to the detectors are not omnidirectional and recording quality and number of recordings is influenced by the orientation of the call relative to the microphone.

2. Methods

2.1 Regulatory Requirements

Amendments were made to the NEMA: EIA Regulations of 2014: GNR 326 EIA Regulations; GNR 327 Listing Notice 1; GNR 325 Listing Notice 2; GNR 324 Listing Notice 3 which pertains to WEF and the activities surrounding their construction. Under Listing Notice 2 it is stated that a Scoping and Environmental Impact Assessment (EIA) is required for WEF with an electricity output 20 MW or more and which is not located in an urban area or on existing infrastructure. Only a Basic Assessment (BA) is, however, required in cases where the entire boundary of the proposed WEF is in a Renewable Energy Development Zone (REDZ) or when the output is below 20 MW. The proposed Dalmanutha WEF is not located in a REDZ but will have an electrical output above 20 MW. Based on The South African Best Practice Guidelines for Pre-construction Monitoring of Bats at Wind Energy Facilities - ed 5 (SABPG, MacEwan *et al.*, 2020), a full 12-month survey is thus required. All methods used to inform desktop studies and conduct field surveys were implemented according to the SABPG (MacEwan *et al.*, 2020).

2.2 Desktop study

A thorough desktop study was undertaken to estimate the likelihood of specific species of bats being present at the proposed WEF. This included investigations into available literature, including Bats of Southern and Central Africa (Monadjem *et al.*, 2020), the African Chiroptera Report (ACR, 2021) and any other bat surveys or monitoring reports for nearby WEF applications as determined from the REEA (2022 Q1) information. Lack of public access to existing monitoring reports for WEFs is a recurring problem in the industry and one that severely hampers pre-construction monitoring studies and the recommendations therein, a problem to be addressed by relevant NGOs and the governmental institutions.

A search was conducted to identify any protected areas present within 100 km of the proposed WEF project area using the South African Protected Area Data (SAPAD 2022 Q1). In addition, a search was conducted to determine if any caves or mine shafts are located close to the PAOI as these are often used by bats as roosts.

2.3 Field surveys

All methodologies used for the bat Screening Survey was planned using the South Africa Best Practice guidelines for Pre-Construction monitoring of Bats at Wind Energy Facilities (MacEwan et al. 2020) as a guide and comply with all good practice guidelines. The first survey was conducted between the 10 and 13 of June 2021 and was considered a Scoping Survey where bat detectors were deployed. An additional four field surveys were conducted to conduct driven transects and roost inspections (Table 1).

Table 1. Summary of field work conducted

Date	Activity	Conditions	Comments
10 – 13 June 2021	Scoping phase	Middle of dry season. Very dry and cold	Bat detectors were deployed, and preliminary roost inspections conducted
24 – 27 September 2021	Driven transects	Still very cold, but grasslands were lush	All transects were driven and data collected
5 – 8 January 2022	Roost inspections and driven transects	Heavy rains during the early mornings and very wet conditions	All potential roosts were inspected, nightly transects driven and data retrieved
4 – 7 April 2022	Driven transects	Veld conditions are dry and climate cold	All transects were driven and data collected
13 – 17 June 2022	Removal of bat equipment	Very cold and dry	All bat equipment removed, and roost inspections performed

2.3.1 Passive surveys

Nightly recordings of bats were captured using the Wildlife Acoustics Bat detector SM4BAT FS Ultrasonic Recorders (hereafter referred to as "bat detectors"). Bat detectors were set to start recording 30 min before sunset until 30 min after sunrise to ensure that all active bats would be recorded. A total of seven bat detectors were deployed across the project AOI. Locations where these detectors were placed were based on a thorough desktop investigation of the area and ground truthing conducted during the Scoping Phase. Subsequently, bat detectors were placed to ensure that all habitat types were monitored and any areas that were deemed to be important to bats (**Error! Reference source not found.** as stipulated the SABPG (MacEwan et al. 2020). This includes having at least one bat detector deployed at a height of 7 - 10 m per 5 000 ha of the PAOI, and one bat detector deployed at a height of 50 – 80 m per 10 000 ha for metrological masts that are 80 m tall. If a mast is taller than 80 m an additional bat detector must be deployed as close to the top of the mast as possible. This considered, five bat detectors were deployed at 10 m above ground, one of these on the metrological masts. A further two bat detectors were deployed at height on the meteorological mast, one 75 m and one at 130 m. During the recording time, the device is 'armed' and will begin a recording if a 'Trigger' is detected. A trigger is defined as a sound within the set frequency range (Default: >16 kHz) amplitude (Default: 12 dB) for a minimum duration (Default: 1.5 ms). The recording then continues for the duration of the Trigger Window (Default: 3 second) after the last Trigger, and then saves the recorded data. If there are constant Triggers, the recording will save and close after the maximum length of a recording file (Default: 00m:15s). The batteries for the bat detectors deployed on small masts were changed approximately every month while the detectors on the metrological mast were powered by solar systems. During the monthly site visits, all data were copied from the SD cards and backed up.

Figure 4. Location of static bat detectors on the Project Area of Influence

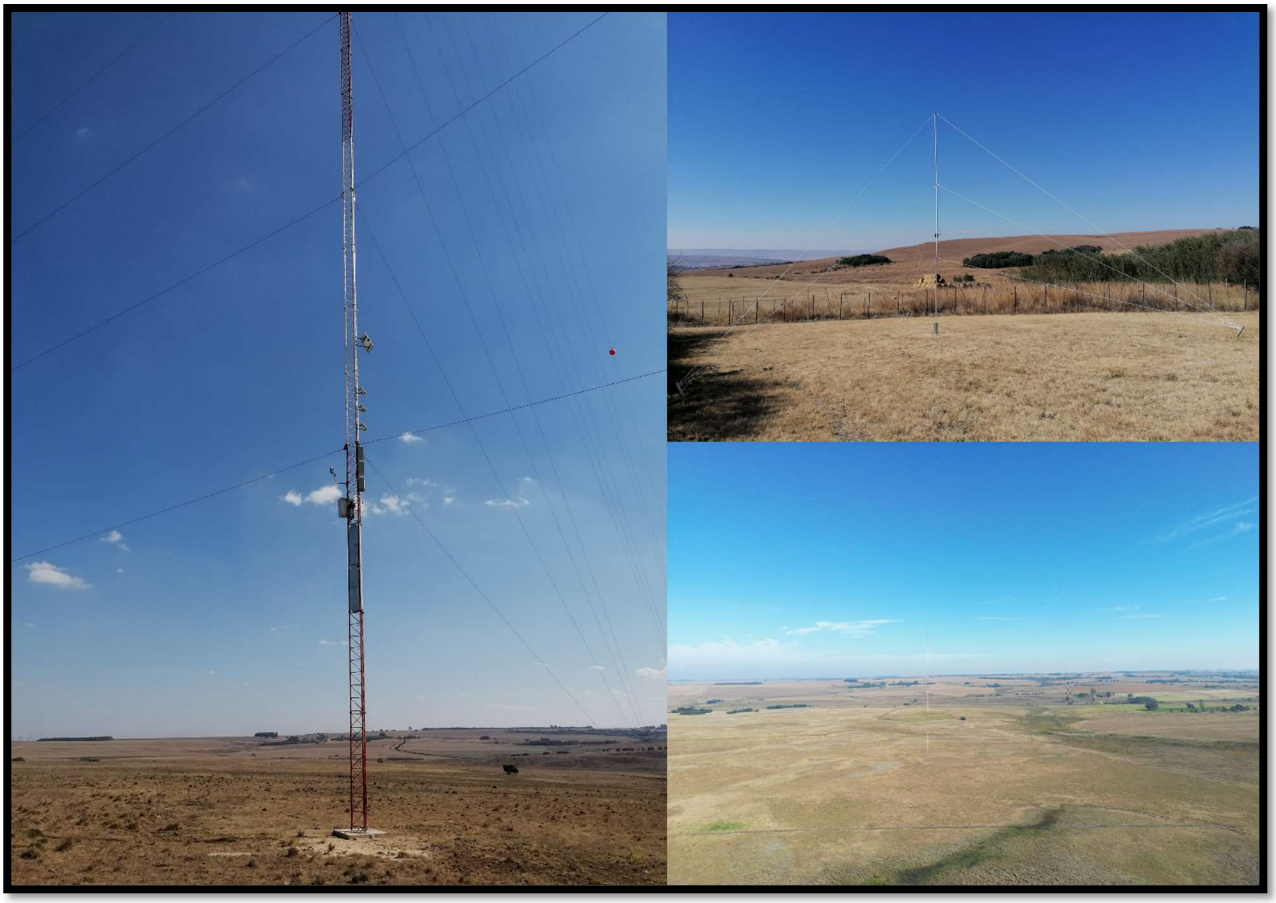


Figure 5. Photographic representation of some masts and bat detectors

2.2.2 Active Surveys

Active surveys were conducted by driving transects across the area with a bat detector mounted on the roof of the vehicle (Table 2). These surveys provided a robust representation of species assemblage, as well as activity patterns across the PAOI and the routes and number of transects employed represented adequate coverage of the PAOI. Surveys began at twilight when conducted in the evening and lasted for at least 2.5 hours. Eight nights of transects were conducted on the proposed WEF.

Table 2. Times and duration of driven transects

Date	Start time	End time	Total
10-Jun 2021	17:09	19:10	02:01
11-Jun 2021	17:18	19:47	02:29
12-Jun2021	17:02	19:26	02:24
24-Sep 2021	17:57	20:30	02:33
25-Sep 2021	17:55	20:40	02:45
05-Jan 2022	18:55	21:10	02:15
06-Jan 2022	18:56	21:45	02:49
05-April 2022	17:19	19:58	02:39
06-April 2022	17:18	20:11	02:57
Total			22:52

2.2.3 Roost surveys

Bats use a variety of roosts including caves, trees, crevices and buildings, and the choice of roost is species dependent (Miller-Butterworth et al., 2003; Pretorius et al., 2020). The location of caves is fairly well known, and historical records in conjunction with active searching can be used to uncover them. Detection of non-cave roosts sites are more difficult and can only be achieved through active searching. Transects were walked on all properties during the day, and potential roosting sites investigated with a bat detector. In addition, the search team was on the lookout for signs of bat activity such as traces of fecal material.

2.3. Data analyses

Kaleidoscope Pro v5.4.0 (www.wildlifeacoustics.com) was used to analyze all bat calls recorded *via* the auto-identification and cluster-analyses features. Due to the lack of release calls from bats in the southern Africa subregion and intra-species variation in bat calls the auto-identification feature is not always 100% accurate but does provide an indication of the potential bat species. As such all clusters created by the software was manually identified based on bat call parameters, including the peak frequency, call duration and bandwidth. Within each cluster one call was selected with a strong amplitude and minimal background noise to identify the species for that cluster.

2.4 Foraging areas

The search team investigated areas with more complex vegetation structures which could potentially act as foraging areas, or areas that could be used as flythroughs. This included, but was not limited to, areas with trees or larger shrubs. It must be noted, however, that the absence of bats in these areas should not exclude these areas as potential foraging habitats.

2.5 Impact assessment

The assessment of impacts and mitigation evaluates the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation.

The key objectives of the risk assessment methodology are to identify any additional potential environmental issues and associated impacts likely to arise from the proposed project, and to propose a significance ranking. Issues / aspects will be reviewed and ranked against a series of significance criteria to identify and record interactions between activities and aspects, and resources and receptors to provide a detailed discussion of impacts. The assessment considers direct[1], indirect[2], secondary[3] as well as cumulative[4] impacts.

[1] Impacts that arise directly from activities that form an integral part of the Project.
[2] Impacts that arise indirectly from activities not explicitly forming part of the Project.
[3] Secondary or induced impacts caused by a change in the Project environment.
[4] Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.

A standard risk assessment methodology is used for the ranking of the identified environmental impacts pre-and post-mitigation (i.e. residual impact). The significance of environmental aspects is determined and ranked by considering the criteria[5] presented in Table 3.

[5] The definitions given are for guidance only, and not all the definitions will apply to all the environmental receptors and resources being assessed. Impact significance was assessed with and without mitigation measures in place.

Table 3. Impact Assessment criteria and scoring system

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low: No impact on processes	Low: Slight impact on processes	Medium: Processes continue but in a modified way	High: Processes temporarily cease	Very High: Permanent cessation of processes
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probability	Definite
Significance (S) is determined by combining the above criteria in the following formula:	$[S = (E + D + R + M) \times P]$ $Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$				
IMPACT SIGNIFICANCE RATING					
Total Score	4 to 15	16 to 30	31 to 60	61 to 80	81 to 100
Environmental Significance Rating (Negative (-))	Very low	Low	Moderate	High	Very High
Environmental Significance Rating (Positive (+))	Very low	Low	Moderate	High	Very High

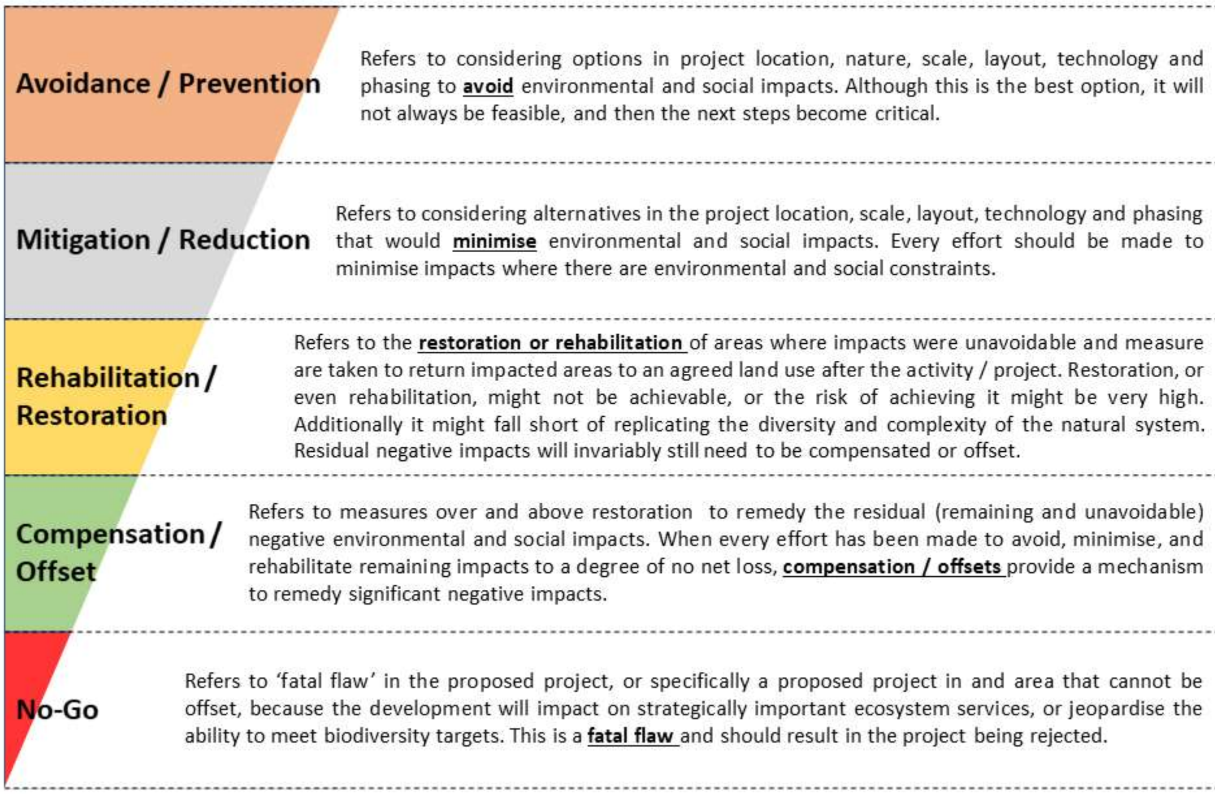
2.6 Impact mitigation

The impact significance without mitigation measures will be assessed with the design controls in place. Impacts without mitigation measures in place are not representative of the proposed development's actual extent of impact and are included to facilitate understanding of how and why mitigation measures were identified. The residual impact is what remains following the application of mitigation and management measures and is thus the final level of impact associated with the development. Residual impacts also serve as the focus of management and monitoring activities during Project implementation to verify that actual impacts are the same as those predicted in this report.

The mitigation measures chosen are based on the mitigation sequence/hierarchy which allows for consideration of five (5) different levels, which include avoid/prevent, minimise, rehabilitate/restore, offset and no-go in that order. The idea is that when project impacts are considered, the first option should be to avoid or prevent the impacts from occurring in the first place if possible, however, this is not always feasible. If this is not attainable, the impacts can be allowed, however they must be minimised as far as possible by considering reducing the footprint of the development for example so that little damage is encountered. If impacts are unavoidable, the next goal is to rehabilitate or restore the areas impacted back to their original form after project completion. Offsets are then considered if all the other measures described above fail to remedy high/significant residual negative impacts. If no offsets can be achieved on a potential impact, which results in full destruction of any ecosystem for example, the no-go option is considered so that another activity or location is considered in place of the original plan.

The mitigation sequence/hierarchy is shown in Figure 6 below.

Figure 6. Mitigation sequence



3. Results

3.1 Desktop survey

A thorough desktop study was undertaken to estimate the likelihood of specific species of bats being present at the proposed WEF. This included investigations into available literature, including Bats of Southern and Central Africa (Monadjem *et al.*, 2020), the African Chiroptera Report (ACR, 2021) and any other bat surveys or monitoring reports for nearby WEF applications as determined from the REEA (2022 Q4) information. Lack of public access to existing monitoring reports for WEFs is a recurring problem in the industry and one that severely hampers pre-construction monitoring studies and the recommendations therein, a problem to be addressed by relevant NGOs and the governmental institutions.

3.1.1 Bat surveys conducted in the area

An online search for all nearby existing and proposed WEFs and Solar facilities was conducted to find additional data regarding important bat findings that might be of importance to the proposed WEF. Investigations into all available literature of other bat surveys or monitoring reports near the proposed WEF application were undertaken (Table 4) as determined from the REEA (2022 Q4) information. These reports identified the potential impact of the proposed energy generating facilities on bat populations present and mitigation strategies followed. Two SEF were identified (Eskom Arnot PV Facility and 14MW Machadodorp PV 1 solar energy facility) in close proximity to the PAOI but contained no available bat assessment reports due to bat monitoring not being a required assessment for solar facilities. The SEF mentioned above show a REEA current status of "Scoping and EIA" and "BAR" respectively. An extensive list of bat species, that could possibly be present on or near to the proposed WEF, was also compiled using the previous study data and publicly available bat ecological information.

Table 4. Bat reports for Wind Energy Facilities in the region of the proposed Wind Energy Facility.

Project	Report details	Consultant
Haverfontein Wind Energy Project	Proposed Haverfontein Wind Energy Project, Carolina Albert Luthuli Local Municipality Mpumalanga Province of South Africa	Animalia Zoological & Ecological Consultation

3.1.1.1 Proposed Haverfontein Wind Energy Project, Carolina Albert Luthuli Local Municipality Mpumalanga Province of South Africa

- The general comment provided by the bat specialist was that the general bat activity in the project area was relatively low and concentrated in certain areas only, and that additionally bat roosting space that are natural to the area is very scarce.
- It was established that only limited buildings and the patches of invader trees occurring on site provide sufficient roosting habitat for specific bat species.
- These areas contain invasive tree species, and it was recommended that they not be conserved.
- It was recommended that the watercourses and farm dam found on the PAOI be buffered as they could attract a number of bats.
- The possibility of migration paths being present on the PAOI still exists and it was recommended that a further long term study be conducted.
- It was recommended that curtailment mitigation measures be implemented on all turbines on the site, based on correlations found between wind speeds and bat activities during the long-term study.

3.1.2 Potential species present in the area

Our desktop study, which included the above-mentioned reports, data from the African Chiropteran Report (ACR, 2020) and Bats of Southern and Central Africa (Monadjem et al., 2020) revealed that 17 species could potentially be found in the area (Table 5). A number of species have been captured within 50 km from the proposed WEF, including five *Laephotis capensis*, one *Miniopterus natalensis*, one *Mops midas* and two *Rhinolophus simulator* (ARC, 2020)

Table 5. Bat species that could potentially occur on the PAOI based on a desktop study

Species name	Common name	Conservation Status IUCN/ SA Red List	Foraging habits	Roosts	Probability of occurrence	Risk of Impact
			NYCTERIDAE			
Nycteris thebaica	Egyptian slit faced bat	LC/LC	Clutter forager	Caves, culverts, and trunks of large trees	Medium	Low
			MINIOPTERIDAE			
Miniopterus natalensis	Natal long-fingered bat	LC/NT	Clutter-edge forager	Caves	High	High
			VESPERTILIONIDAE			
Eptesicus hottentotus	Long-tailed serotine	LC/LC	Clutter-edge forager	Caves and rock crevices	Medium	Medium
Neoromicia capensis/Laephotis capensis	Cape serotine	LC/LC	Clutter-edge forager	Under the bark of trees, foliage, and buildings	High	High
Myotis tricolor	Temminck's myotis	LC/NT	Clutter-edge forager	Caves	Medium	Medium
Pipistrellus hesperidus	Dusky pipistrelle	LC/LC	Clutter-edge forager	Wooded areas in trees as well as cracks in rocks	High	Medium
Scotophilus dinganii					High	
			RHINOLOPHIDAE			
Rhinolophus blasii	Blasius's horseshoe bat	NT/V	Clutter forager	Caves and mines	Medium	Low
Rhinolophus simulator	Bushveld horseshoe bat	LC/LC	Clutter forager	Caves and mines	Medium	Low
Rhinolophus clivosus	Geoffroy's horseshoe bat	LC/NT	Clutter forager	Caves and mines	Medium	Low
			MOLOSSIDAE			
Tadarida aegyptiaca	Egyptian free tailed bat	LC/LC	Open-air forager	Caves, rock crevices, under exfoliating rocks, hollow trees, behind the bark of dead trees and buildings	High	High
Mops midas	Little Free-tailed Bat	LC/LC	Open-air forager	Caves, rock crevices, under exfoliating rocks, hollow trees, behind the bark of dead trees and buildings	High	High

Species name	Common name	Conservation Status IUCN/ SA Red List	Foraging habits	Roosts	Probability of occurrence	Risk of Impact
			HIPPOSIDERIDAE			
Cleotis percivali	Percival's short-eared trident bat	CR/ V	Clutter forage	Caves and mines	Low	Low
			EMBALLONURIDAE			
Taphozous mauritianus	Mauritian tomb bat	LC/LC	Open-air forager	Open-air forager	High	High
			PTEROPODIDAE			
Rousettus aegyptiacus	Egyptian rousette	LC/LC	Clutter forager	Caves	Low	High
Epomophorus wahlbergi	Wahlberg's Epauletted Fruit bat	LC/LC	Clutter forager	Roosts in dense foliage of large, leafy trees	Medium	High
Epomophorus crypturus	Peters's epauletted fruit bat	LC/LC	Clutter forager	Roosts in dense foliage of large, leafy trees	Low	High

3.1.3 Protected areas

A search was conducted to identify any protected areas present within 100 km of the proposed WEF project area using the South African Protected Area Data (SAPAD 2022 Q1). The identified public/privately owned protected areas are listed in the table below (Table 6). The reserves consist of privately as well as publicly owned land used for wildlife conservation as well as specific livestock farming. These sites are all registered designated protected areas (SAPAD 2022, Q1).

Table 6. The identified public/privately owned protected areas identified close to proposed WEF site

Name	Location from WEF
Nooitgedacht Dam Nature Reserve	5 Km Southwest
Paulina Van Niekerk Private Nature Reserve	6 Km Southeast
Rentia Kritzinger Private Nature Reserve	22 Km South
St Louis Private Nature Reserve	22 Km South
Chrissiesmeer Protected Environment	34 Km South
Bewerwyk Private Nature Reserve	28 km Southeast
Maffia Private Nature Reserve	28 km Southeast
Laughing Waters Private Nature Reserve	54 Km Southeast
Ahlers Private Nature Reserve	62 Km South
Rietvlei Private Nature Reserve	74 Km Southwest
Langcarel Private Nature Reserve[6]	80 Km South
Jericho Dam Nature Reserve	84 Km Southeast
Josua Moolman Private Nature Reserve	86 Km Southeast
Cecilia Private Nature Reserve	19 Km West
Vaalbank Private Nature Reserve	58 Km West
Heyns Private Nature Reserve	64 Km West
Burnside Private Nature Reserve	64 Km West
Witbank Nature Reserve	77 Km West

[6] process is under way to de-proclaim this nature reserve.

Name	Location from WEF
John Cairns Private Nature Reserve	90 Km West
Botshabelo Nature Reserve	61 Km West
Bezuidenhoutshoek Nature Reserve	73 Km West
Nederwelt Private Nature Reserve	43 Km Northwest
Loskop Dam Nature Reserve	84 Km Northwest
Buks Private Nature Reserve	70 Km Northwest
Greater Lakenvlei Protected Environment	9 Km North
Langkloof Private Nature Reserve	9 Km Northwest
Grootrietvley Private Nature Reserve	46 Km Northwest
Kwaggavoetpad Nature Reserve	79 Km Northwest
Berg-En-Dal Private Nature Reserve	100 Km Northwest
Christiaans Private Nature Reserve	74 Km Northwest
Mantrombi Nature Reserve	89 Km Northwest
Verloren Valei Nature Reserve	39 Km North
Houtenbek Private Nature Reserve	39 Km North
Kleinsuikerboskop Private Nature Reserve	40 Km North
Tobe Private Nature Reserve	40 Km Northeast
Davel Private Nature Reserve	54 Km North
De Hoop Dam Protected Environment	73 Km North
Steelpoort Private Nature Reserve	82 Km North
J. M. Beetge Private Nature Reserve	70 Km Northeast
Kudu Private Nature Reserve	85 Km Northeast
Lydenburg Nature Reserve	73 Km Northeast
Sterkspruit Nature Reserve	78 Km Northeast
Kruger To Canyons Biosphere Reserve	84 Km Northeast

Name	Location from WEF
Mount Anderson Catchment Nature Reserve	86 Km Northeast
Buffelskloof Private Nature Reserve	56 Km Northeast
Wonderkloof Nature Reserve	64 Km Northeast
Vischspruit Private Nature Reserve	70 Km East
Red Acres Private Nature Reserve	59 Km Northeast
Tullach Mhor Private Nature Reserve	47 Km East
Vlakplaats Private Nature Reserve	54 Km East
Ngodwana Valley Nature Reserve	55 Km East
Vischspruit Private Nature Reserve	72 Km Northeast
Umhloti Nature Reserve	90 Km East
Barberton Nature Reserve	83 Km East
Nelsberg Reserve	58 Km East
Barberton Makhonjwa World Heritage Site	45 Km East

3.2 Caves and mine shafts

In addition to protected areas present around the proposed WEF site, a search for cave roosts or abandoned mine shafts was conducted. Cave–dwelling bats are known to use abandoned mine shafts as regular roosting sites. Bat populations are often driven from their traditional roosts by human disturbance and cave commercialisation, thus abandoned mines offer the advantage of a stable microclimate, reduced risk from predation and disturbance, and protection from adverse weather (Miller-Butterworth *et al.,* 2003; Pretorius *et al*., 2020). This does create the possibility of additional bat roosts being present close to the PAOI. Mining in Mpumalanga is known to produce valuable quantities of minerals to South Africa's industry. This includes chrome, coal, gold, industrial, iron ore, nickel and PGM (Platinum Group Metal). The coal extracts account for 83% of South Africa's coal production. Although mining activities around the PAOI primarily consists of open cast mining, there is the possibility of suitable roosting environments forming from these activities. No active roosting sites are currently known within a close proximity of the PAOI.

3.3 Passive monitoring

Seven bat detectors were deployed across the PAOI in such a manner as to monitor all habitat types across the PAOI, five of these were at 10m above ground level, one at 80m and one at 140 m (Table 6, Figure 4). The bat detectors were active for a total of 27 650 hours and captured a total of 178 983 bat passes with a median of 0,27 bat passes per hour. It must be noted that all detectors did not record between 12 and 15 July and 10 and 22 May 2022 due to battery failure. In addition, SD cards were stolen from DAL 1, DAL 2 and DAL 3 and no data was captured between 1 October and 26 November 2021. Even with the downtime of this bat detector, we still recorded data for more than 75% of the time and as such comply with the minimum requirements regarding duration recorded (MacEwan *et al.*, 2020).

Table 7. Bat detectors placed across the proposed area of influence

Bat detector	Microphone height	Habitat	Sum of bat passes	Median number of passes
DAL 1	10 m	Drainage line	1 782	0,00
DAL 2	10 m	Water	101 405	11,20
DAL 3	10 m	Vegetation	5 485	0,64
DAL 4	10 m	Lower altitude	57 568	9,09
DAL 5	10 m	Grassland	12 462	1,49
DAL 6	80 m	Height	840	0,00
DAL 7	130 m	Height	47	0,00

3.3.1 Bat passes per species

A total of nine bat species from four families were detected during the monitoring period (Table 7). All these species are listed as Least Concern based on the IUCN Red Data list and are not endemic to South Africa. These species were detected with varying degrees of frequency with *L.*

capensis being the most commonly recorded species across the AOI. All species that were detected has a medium to high or high risk of collision with wind turbines.

Table 8. Bat species recorded during the survey period

Species name	Common name	Conservation Status	Foraging habits	Risk of Impact[7]	Median BP/H
Family: Vespertilionidae					
Laephotis capensis	Cape serotine	Least concern	Clutter-edge	High	14,68
Scotophilus dinganii	Yellow-bellied house bat	Least concern	Clutter-edge	Medium to high	1,35
Myotis bocagii	Rufous myotis	Least concern	Clutter-edge	Medium to high	1,18
Pipistrellus rusticus	Rusty pipistrelle	Least concern	Clutter-edge	Medium to high	0,51
Pipistrellus hesperidus	Dusky pipistrelle	Least concern	Clutter-edge	Medium to high	0,08
Family: Miniopteridae					
Miniopterus natalensis	Natal long-fingered bat	Least concern	Clutter-edge	High	0,14
Family: Emballonuridae					
Taphozous mauritianus	Mauritian tomb bat	Least concern	Open-air	High	0,00
Family: Molossidae					
Mops midas	Midas free-tailed bat	Least concern	Open-air	High	0,27
Tadarida aegyptiaca	Egyptian free-tailed bat	Least concern	Open-air	High	0,97

The average number of bat passes recorded per species followed what is expected of typical bat activity during feeding, with activity peaking early in the evening, at 19:00, and declining throughout the evening (Figure 7 and 8). *Laephotis capensis* showed another increase in activity at 4:00, possibly when individuals return to their roosts. Due to the large numbers of *L. capensis* detected we display the recorded activity without including this species to better present the activity of other species (Figure 8). This then indicated that *M. bocagii* was highly active at 19:00,

[7] MacEwan *et al*., 2020

but most species displayed a similar activity patterns. *Scotophilus dinganii* also increased at 4:00 and was the only species together with *L. capensis* that showed any activity at 16:00 and 6:00.

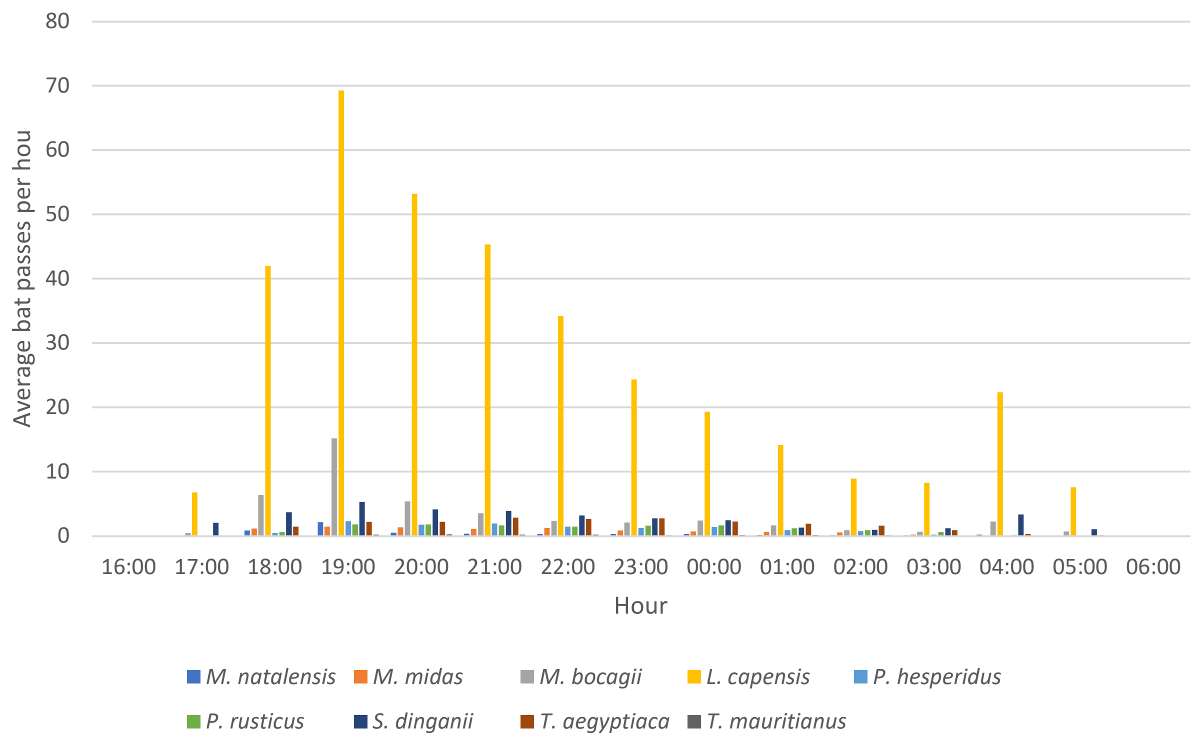


Figure 7. Hourly bat activity per bat species displayed as the average bat passes per hour.

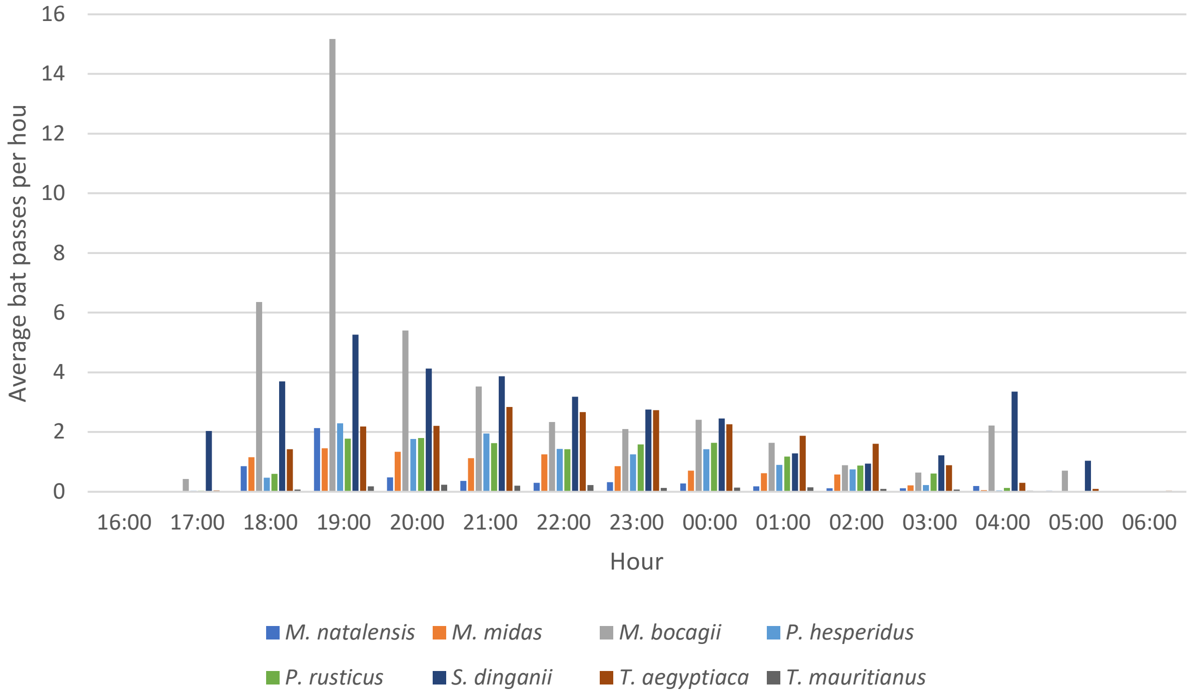


Figure 8. Hourly bat activity per bat species displayed as the average bat passes per hour with *L. capensis* excluded.

There were no clear spikes of activity on any specific day for any species across the monitoring period (Figure 9 and Figure 10). It is however clear that activity levels for *L. capensis* starts increasing towards the end of September and slowly starts decreasing during the middle of January. This is an indication of these bats giving birth to offspring in the area as they start migrating to breeding colonies during spring to give birth and migrate back to winter roosts once pupping is done. A similar trend is observed for other species, with activity peaking between December and January. *Pipistrellus rusticus*, however, shows a peak later during March, which possibly indicated that this species does not breed in the area, but rather moves across the PAOI during specific times of the year.

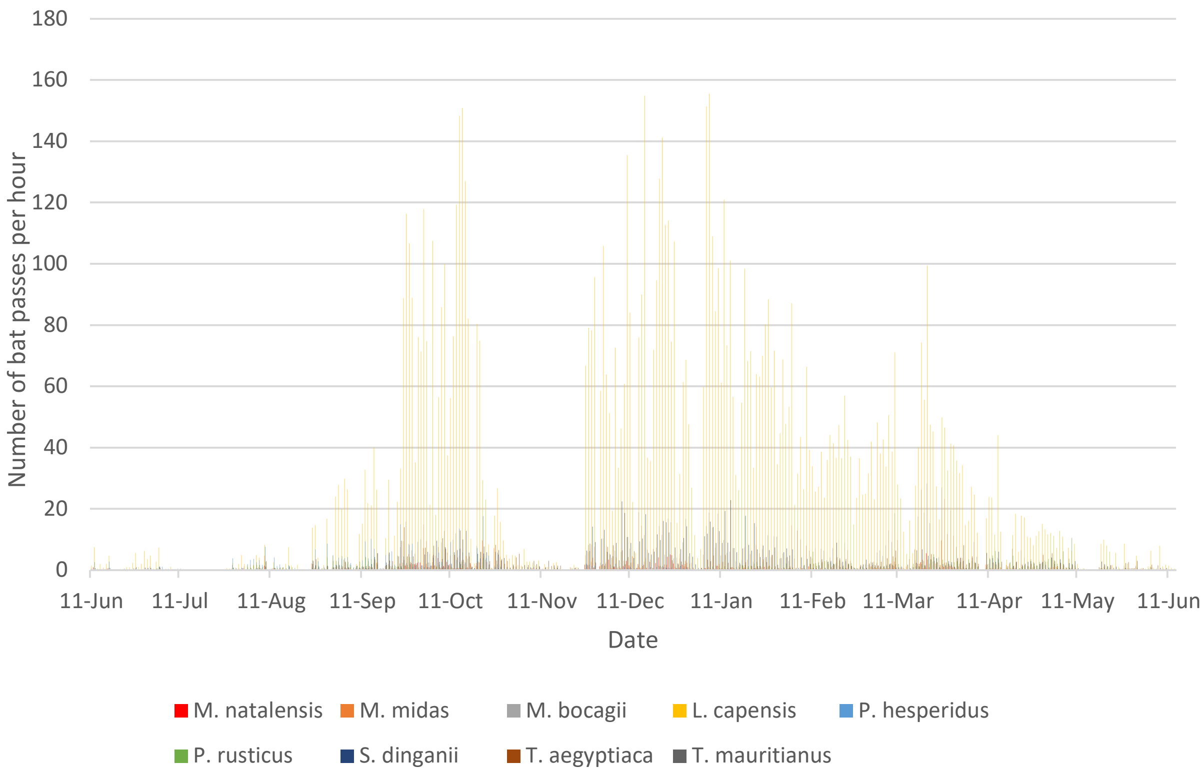


Figure 9. Daily bat passes per hour across the Project Area of Influence

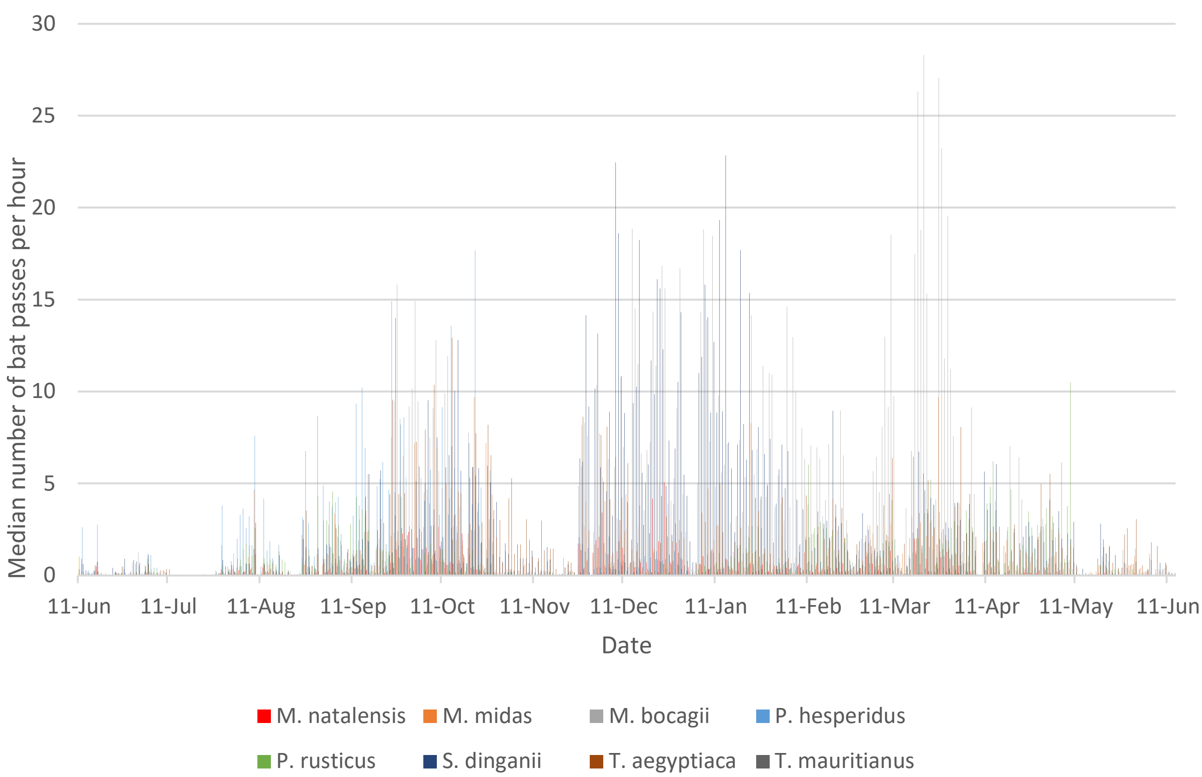


Figure 10. Number of bat passes per species across the monitoring period with *L. capensis* not included.

When only considering the median number of bat passes per month, a similar trend is observed, with bat activity peaking between October and January (Figure 11 and 12). What is more apparent is the increased activity of *S. dinganii* in December and the decline in activity thereafter. This again indicates that there is breeding activity for this species in the area. *Scotophilus dinganii* will roost and give birth in buildings, and it is likely that this species has formed a breeding colony in one or more of the buildings in the property. *Myotis bogacii* also showed increase activity during this period. Very little is known about the breeding and roosting behaviour of this species, but they have been captured in plantations (Monadjem et al*.,* 2020). *Pipistellus hesperidus* had higher activity during September and declined in October showing that this species probably does not breed in the area. The elevated activity of *T. aegyptiaca* during October shows that this species also moves into the area, but the lack of activity during December would indicate that they give birth elsewhere. This species has been shown to pup during December (Mondajem et al., 2020) and we would have expected higher levels of activity during December and January if they gave birth at a roost located on the PAOI.

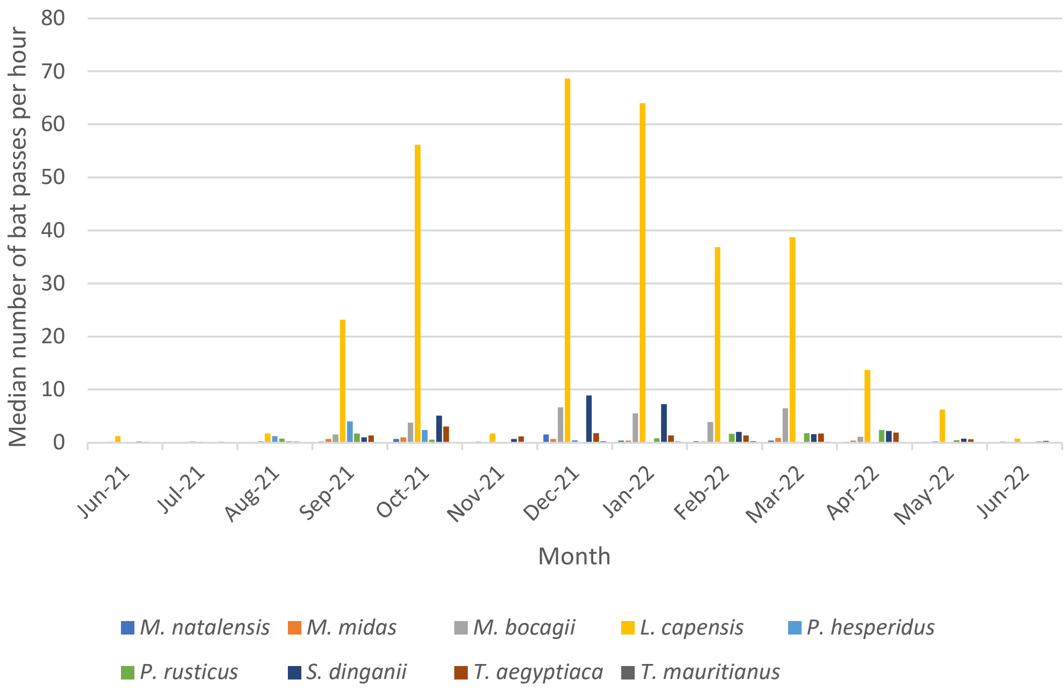


Figure 11. Median number of bat passes per species per month

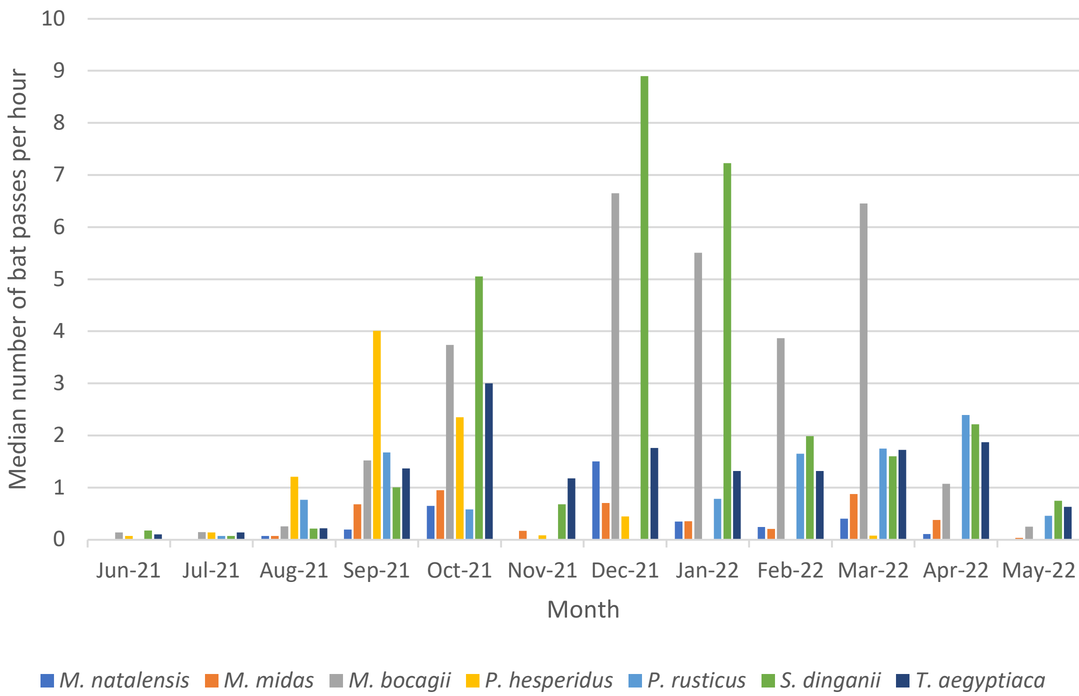


Figure 12. Median number of bat passes per species per month with *L. capensis* excluded

Seasonal activity shows a similar pattern to that observed for monthly activity (Figure 13 and 14). *Laephotis capensis* had very high activity during summer, but rapidly declined during winter. *Myotis bogacii* and *S. dinganii* also shows pronounced spikes during summer, support the theory that they do breed in the area. All other species seem to maintain a relatively constant level of activity across the autumn, spring, and summer with very low activity during winter. This would suggest that there is no influx of these species during specific times of the year and no large maternity colonies forming. This does not, however, mean that there is no breeding activity for these species. The lack of activity detected during winter months is more likely due to an inactivity of bats during colder periods as there is likely to be fewer insects around to feed on, and not necessarily that they move out of the area during this time (Amorim *et al*., 2012).

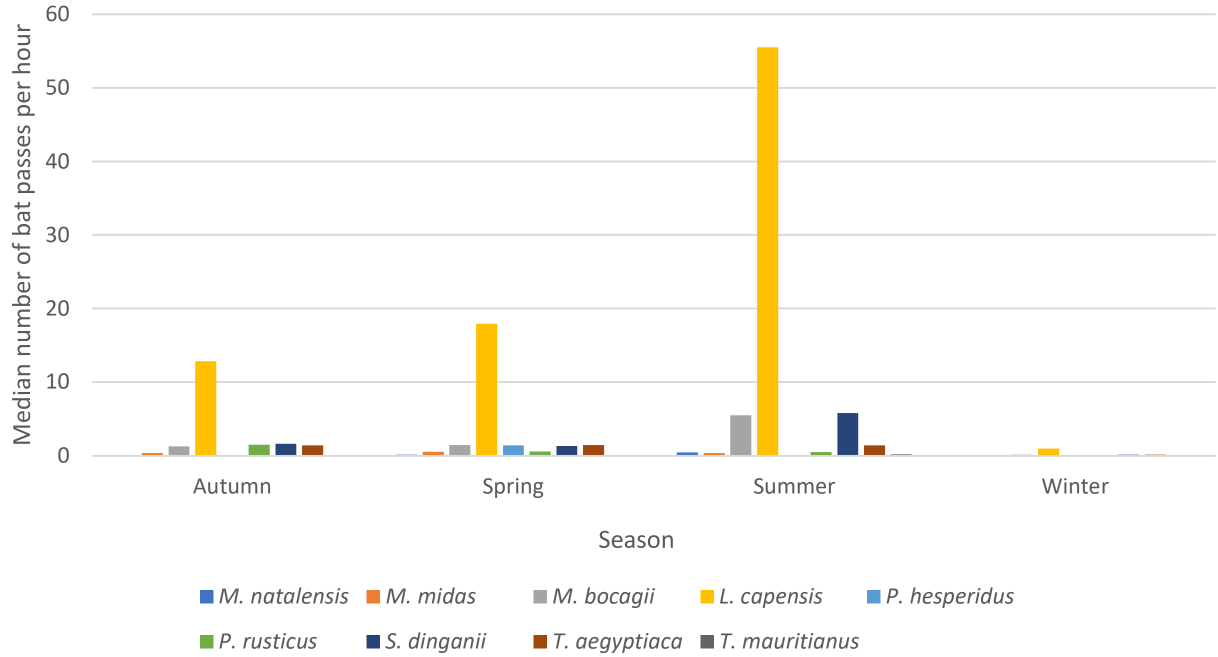


Figure 13. Median number of bat passes per hour across seasons

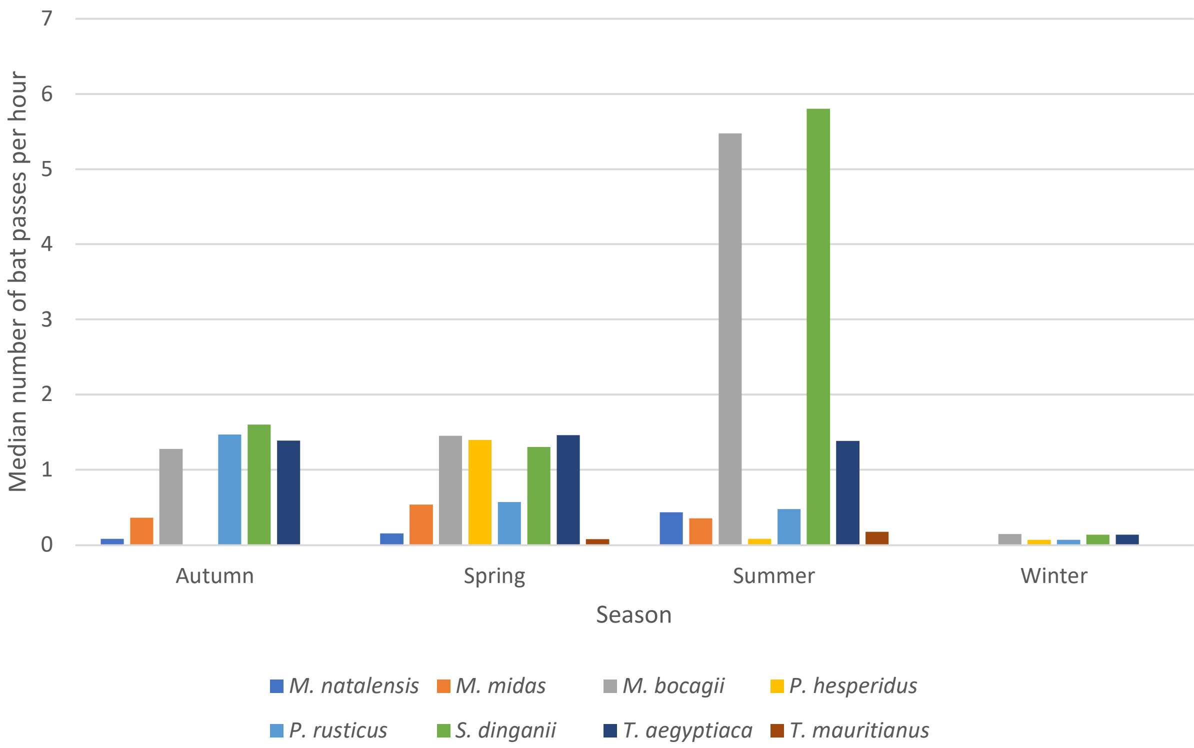


Figure 14. Median number of bat passes per hour across seasons with *L. capensis* excluded

3.3.2 Bat passes per bat detector

Bat activity recorded per hour per bat detector followed a similar pattern than that seen for the activity levels of species (Figure 15). Bats are active early in the evening at 19:00 and then activity decreases throughout the evening. This is especially pronounced at DAL 2 and DAL 4, the detectors located close to a water source and in the low-lying area. There is another increase in active at 4:00 for these two detectors. Activity levels at other detectors are relatively constant throughout the night, but there is still an increase in recorded activity between 18:00 and 20:00. These data indicated and underlined the importance of water sources to bats, especially early in the evening when bats emerge to drink water and start foraging. The relatively high activity during the rest of the night at DAL 2 would suggest that bats also forage around this water source. DAL 4 was located near a building with a roost, and this high activity is indicative of bats leaving the roost and returning in the morning hours. Foraging activity occurs over the rest of the POAI, but not in a significant manner. The lack of activity at DAL 7, the detector deployed at 140 m indicates that bats do not forage at height in a significant fashion in this area.

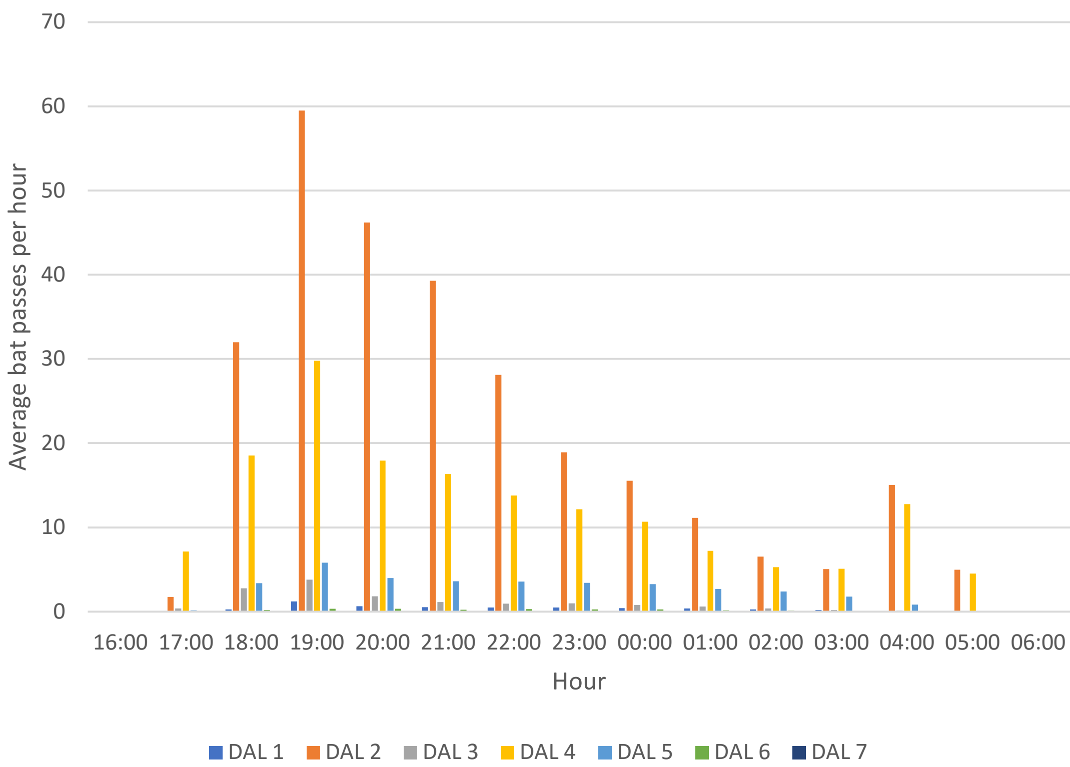


Figure 15. Average bat passes per hour across the Project Area of Influence for each bat detector

There is a noticeable increase in activity at DAL 2 from the end of September 2021, and activity at DAL 4 also seems to increase during this time (Figure 16). Although there are few peaks on specific days, there is a sudden increase in activity at DAL 2 in March 2022, and this could be linked to unusual climatic events or spikes in insect abundance. There is a noticeable decline in activity after this, and activity is very low from May 2022 into June 2022. While activity at other detectors seems to remain stable, there is an increase at DAL 5, the bat detector deployed at 10 m on the met mast during February and March 2022, and this could be attributed to bats migrating out of the area or foraging in the grasslands.

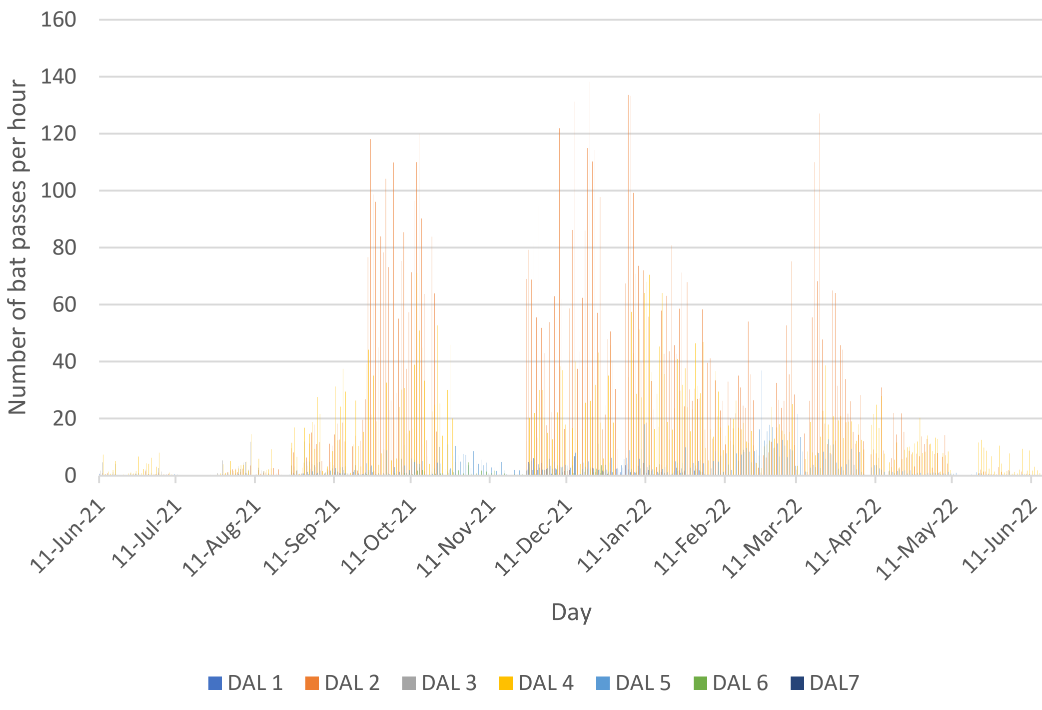


Figure 16. Number of bat passes per hour per day across the Project Area of Influence for each bat detector

Monthly activity follows a similar pattern as was described above. It must be noted that activity for November is based on data collected across four days, and not representative for the full period. Based on the trends observed from the graph (Figure 17), it does however seem to follow the same pattern. There is a noticeable increase in activity at DAL 4 during January 2022, and this can be attributed to young bats becoming volant and leaving the roost. Activity declines at all detectors, except DAL 5, after this. The increase during March 2022 at DAL 5 is most likely due to bats moving out of the area, or more foraging across the grasslands during this period.

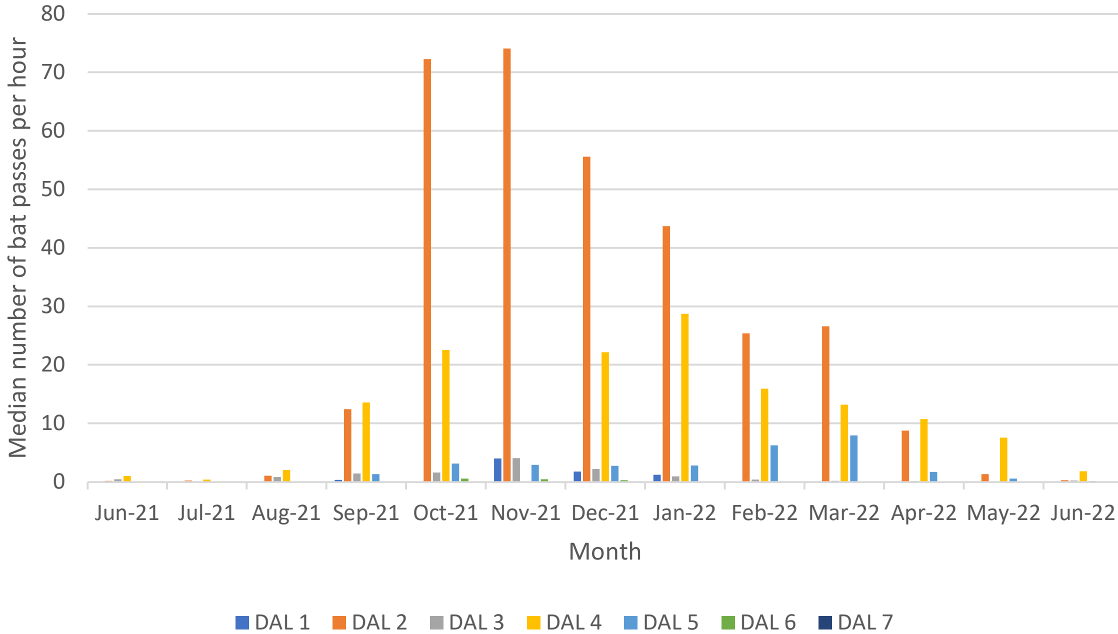


Figure 17. Median number of bat passes recorded per month across the Project Area of Influence

Activity increases from spring, peaks in summer and declines to extremely low levels in winter, and this is highly noticeable for DAL 2 and DAL 4 (Figure 18). Water sources are thus clearly an important resource for bats during autumn, spring, and summer, but seems to be of lesser importance during winter and activity is higher at vegetated areas (DAL 3) during this season. Insect abundance could thus be higher in these areas during the colder months. During winter activity is highest at DAL 4, a detector located near a roost, indicating that this roost is occupied during the winter months, though to a lesser extent. DAL 1 only recorded bat activity during spring and summer, and DAL 6 only during spring. These areas thus seem to be of lesser importance to bats during these seasons. DAL 1 was located in similar habitat, grassland, then DAL 5 – 7, but next to a drainage line, and this is possible the only reason why more activity was recorded at this detector.

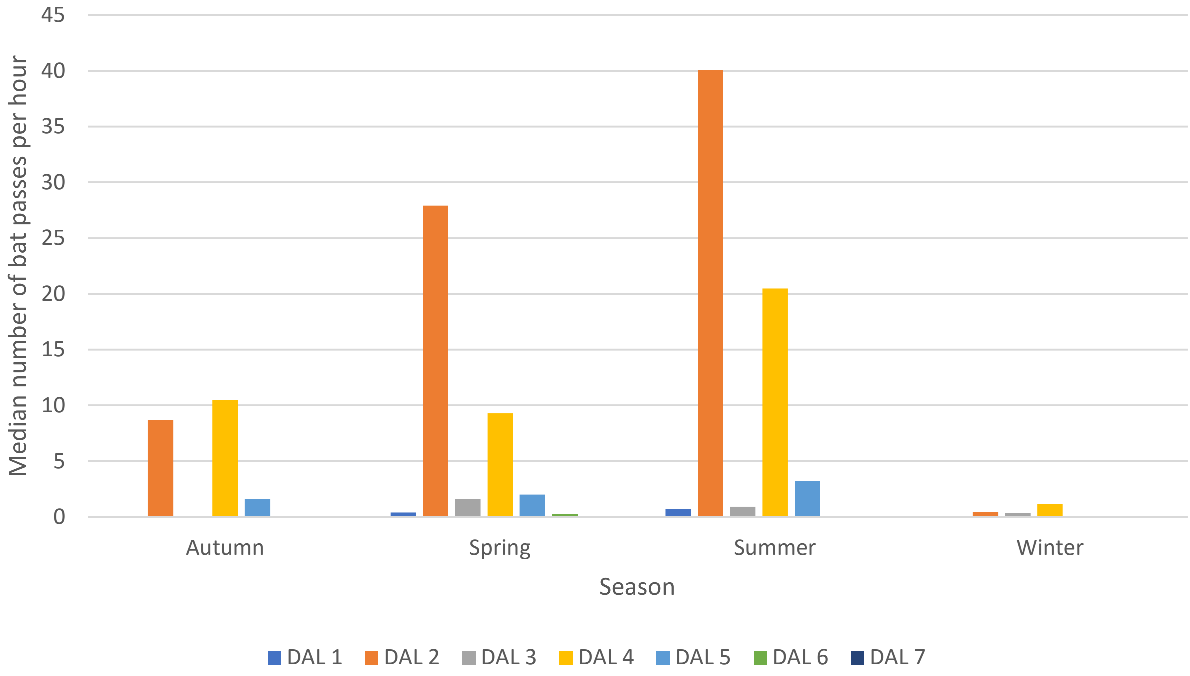


Figure 18. Median number of bat passes recorded per season per detector across the Project Area of Influence

3.3.3 Bat passes at height.

The median number of bat passes per hour was higher at 10 m than any detector deployed at height for all months (Figure 19 and Figure 20). This held true whether all detectors placed at 10 m were considered or only the detector deployed on the met mast. Interesting to note is that the detector deployed at 80 m only recorded a noteworthy number of calls between October and December 2021, indicating that this is the only times of the year that bats forage at height. The detector at 130 m never recoded a significant number of calls and had a median of 0,00 bat passes per hour for most months.

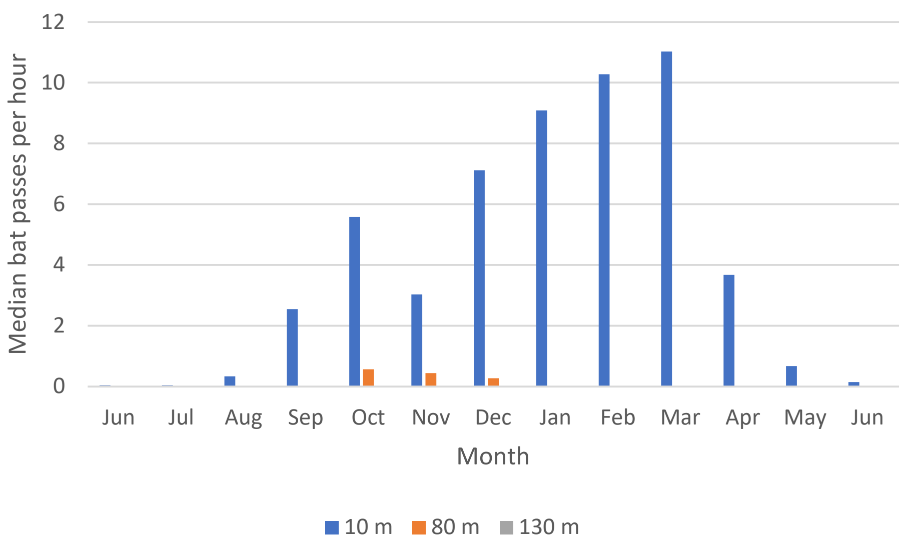


Figure 19. Median number of bat passes recorded per night per month with all bat detectors deployed at 10 m considered.

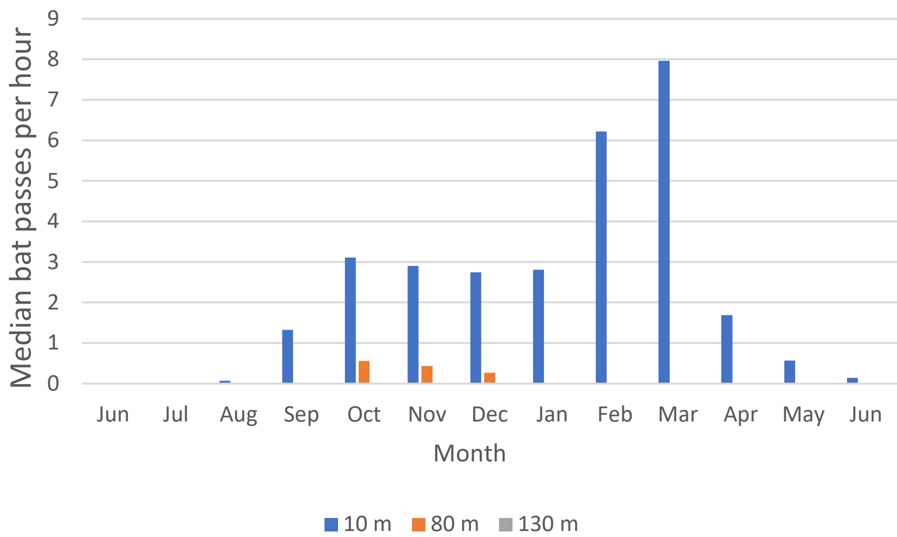


Figure 20. Median number of bat passes recorded per night per month with all bat detectors deployed on the met mast considered.

When seasons are considered, there was only activity at 80 m during spring (Figure 21 and Figure 22). All detectors deployed at 10 m had the highest activity during summer, which is expected based on previously reported results, and extremely little activity during the winter months. The activity increase during spring could be explained by an increase in specific insects due to the change in season and subsequent blooming of flowers (Forrest and Thomson, 2011).

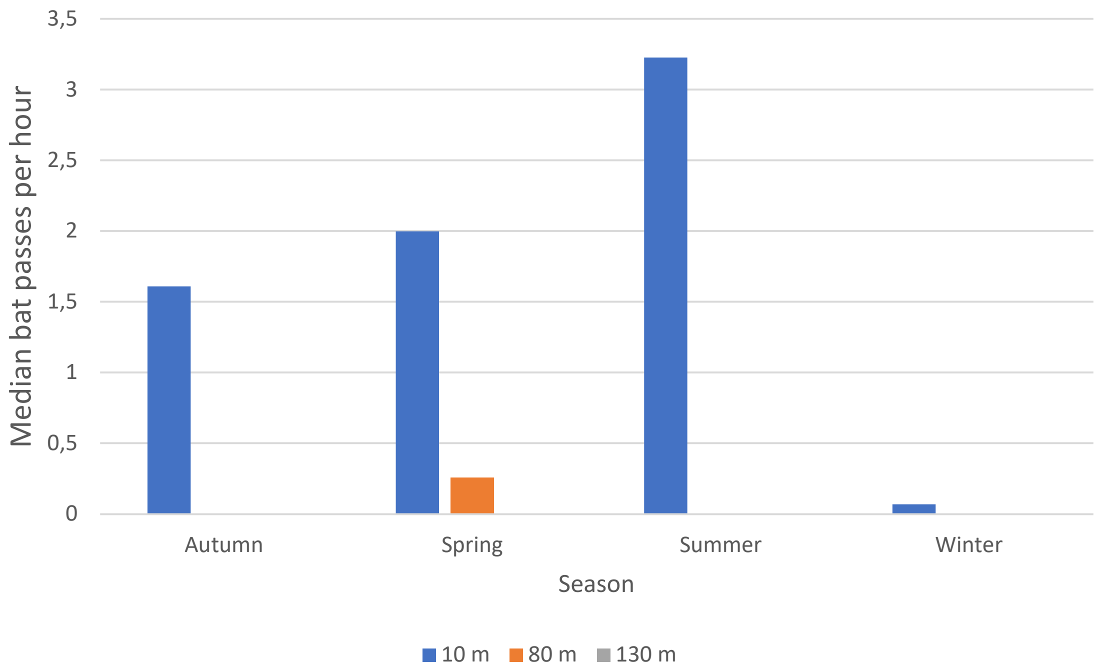


Figure 21. Median number of bat passes recorded per night per season with all bat detectors deployed at 10 m considered.

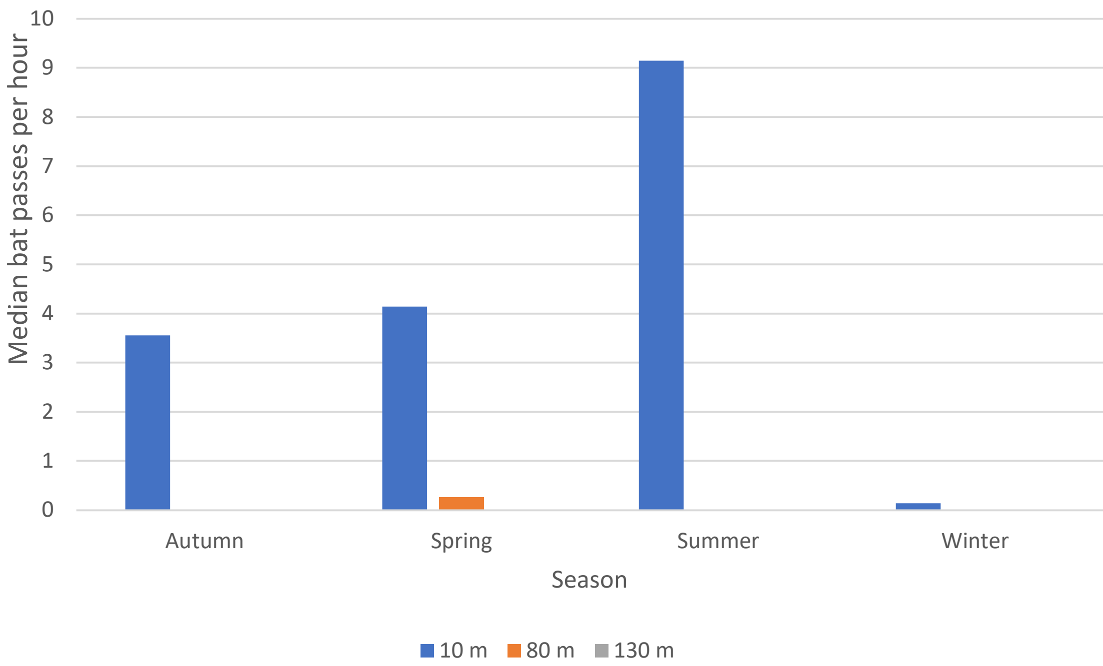


Figure 22. Median number of bat passes recorded per night per season with all bat detectors deployed on the met mast considered.

3.4 Influence of climatic conditions on bat activity

3.4.1 Wind speeds

Wind speed has been shown to have an effect on bat activity, and bats tend to be more active at lower wind speeds (Erikson & West, 2002; Amorim *et al*., 2012; de Jong et al., 2021). Based on our data (Figure 23) we found no correlation between wind speeds and bat activity, and there seems to be no effect. It must, however, be stated that wind speeds were not measured at ground level, but at 60 m above the ground. Wind speeds are known to vary with variation in altitude, and it is thus possible that these data are not an accurate representation of the effect of wind speeds on bat activity (Bañuelos-Ruedas *et al*., 2010). This is especially relevant when we consider the lack of bat activity at higher altitudes.

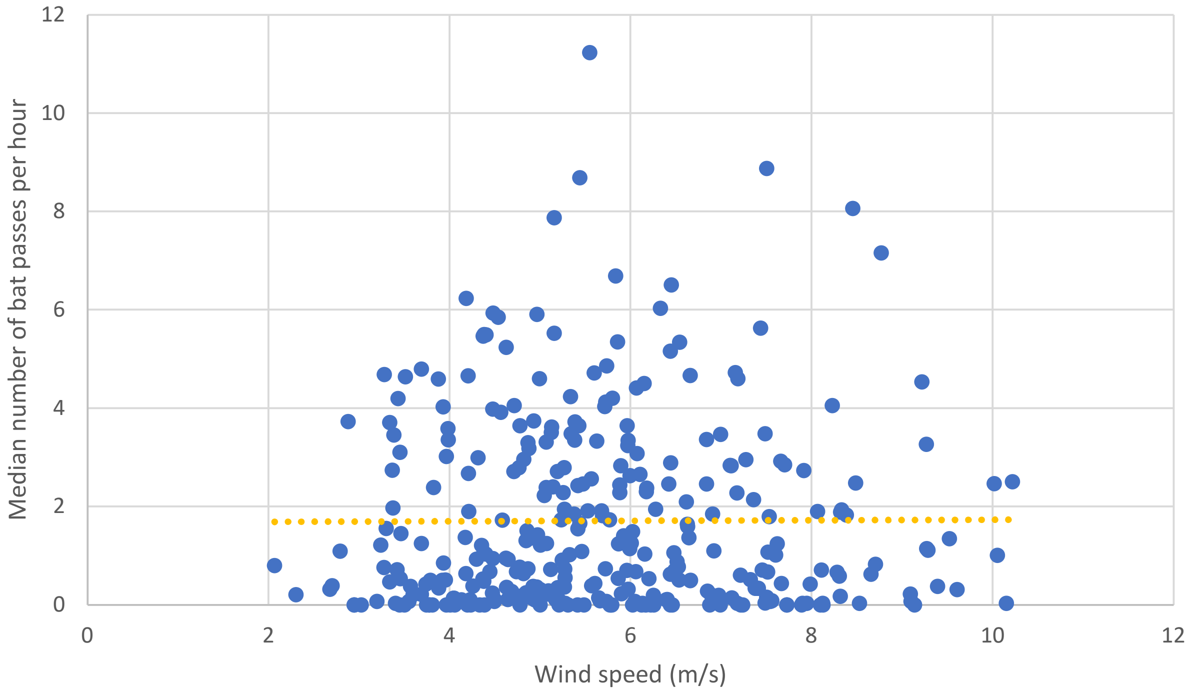


Figure 23. Correlation between bat activity (median BP/H) and wind speed (m/s)

3.4.2 Temperature

Bats are less active at lower temperatures because the insects that they prey on tend to be inactive during these periods (Erikson & West, 2002; Amorim *et al*., 2012; de Jong et al., 2021). Our data indicates that bats are less active at lower temperatures, and that activity only increases above 10 °C. (Figure 24). Flight is already an energy costly mode of transportation, and at lower temperatures even more energy needs to be expended giving another explanation for the lower levels of activity at colder temperatures (Amorim et al., 2012).

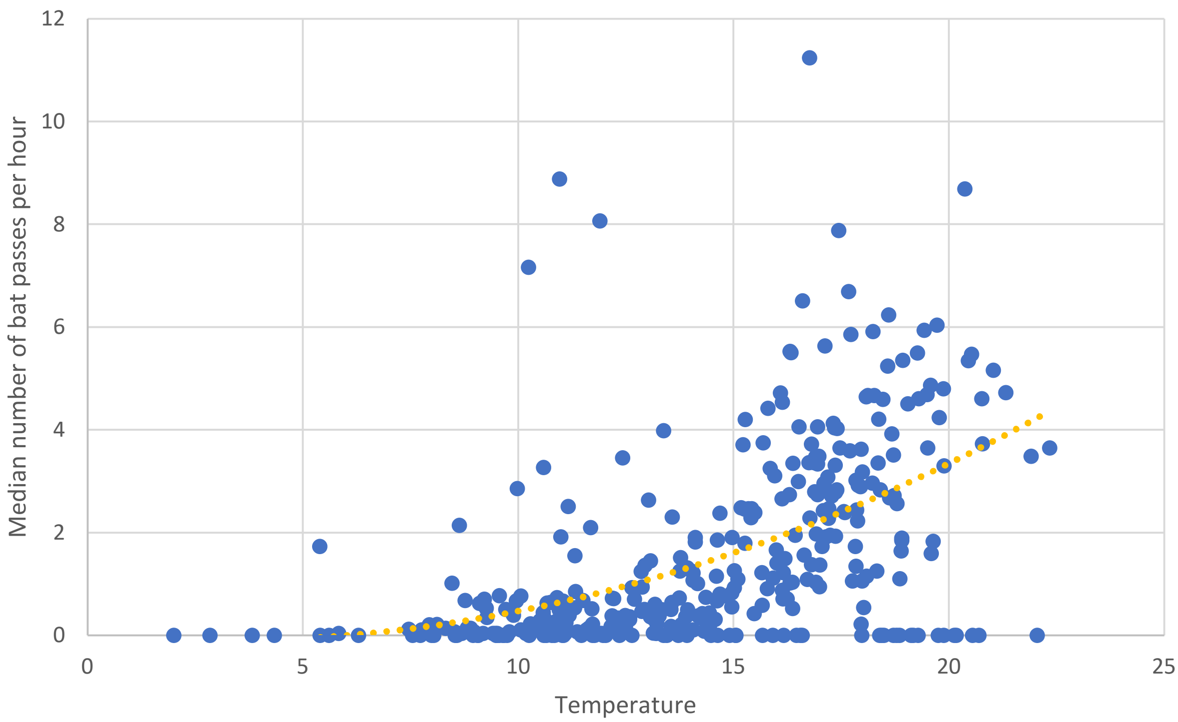


Figure 24. Correlation between ambient air temperature (°C) and bat activity

3.4.3. Barometric pressure

Bats have been shown to be less active when barometric pressure is higher, but the reasons for this is unclear (Squires *et al*., 2021). This is quite likely more related to seasonal changes and the associated temperatures as barometric pressure tends to be higher during colder months. It is, however, clear that bats found on the PAOI follow this trend of less activity at lower barometric pressure (Figure 25).

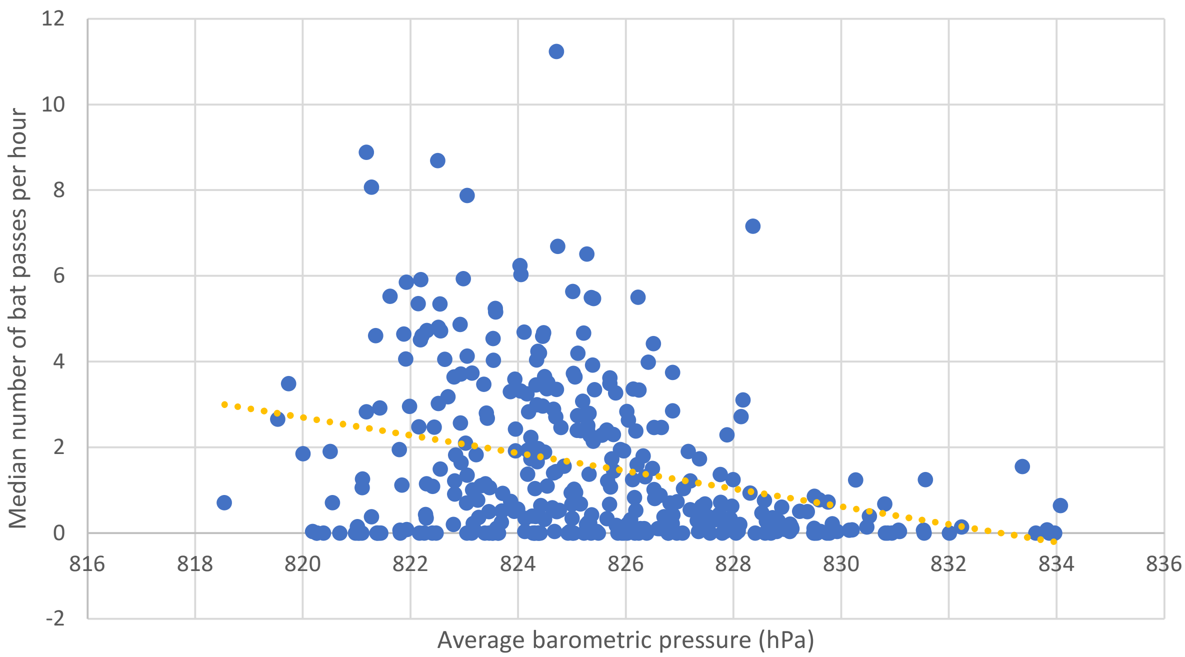


Figure 25. Correlation between barometric pressure (hPa) and the median number of bat passes per hour

3.4.4 Relative humidity

No rainfall data was available for the duration of this assessment, only data on relative humidity. Humidity can indirectly affect bat activity as larval development of insects is correlated to relative humidity (Amorim at al. 2012). We found no direct correlation between the activity levels of bats and relative humidity (Figure 26). There were, however, not many distinct spikes in bat activity across the monitoring period, but rather long periods of increased activity during the warmer months and reduced activity during colder winter months.

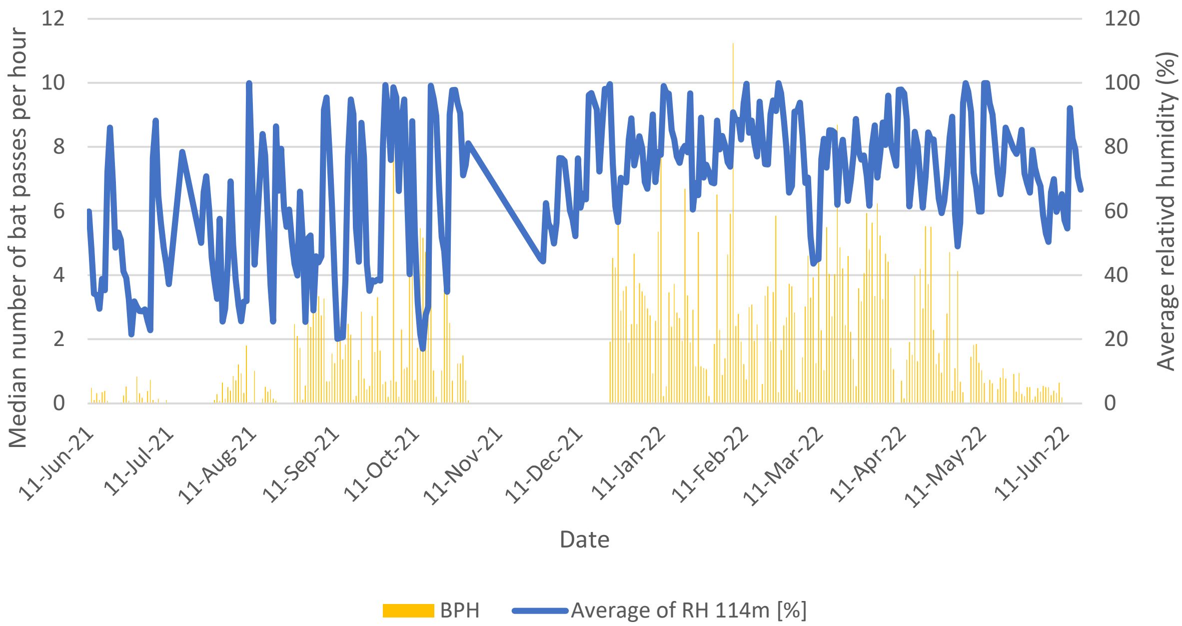


Figure 26. Relationship between relative humidity (%) and median number of bat passes per hour

3.5 Active monitoring

Transects were driven once per season for a minimum duration of 2,5 h per night for two nights. An attempt was made to drive the same roads during all seasons as to obtain an accurate representation of the area and comparable data.

The winter transects were driven during June 2021, and relatively few bats were recorded. The most commonly recorded bat species was *L. capensis* with activity centred mostly around water sources (Figure 27). Activity increased in September, but results remain relatively similar with *L. capensis* being the most abundant species recorded and mostly around water sources (Figure 28). It is interesting to note the number of species recorded increased drastically during these transects and indicated again that species start moving into the PAOI during this period. January saw a large increase in the number of individuals recorded (Figure 29). While activity is still extremely high around water sources, there is also a clear increase in both *L. capensis* and *S. dinganii* in the south.

Except for this increase and high activity around water sources, we recorded high activity across the area. During April there was a marked decrease in both the number of calls recorded and the number of species (Figure 30).

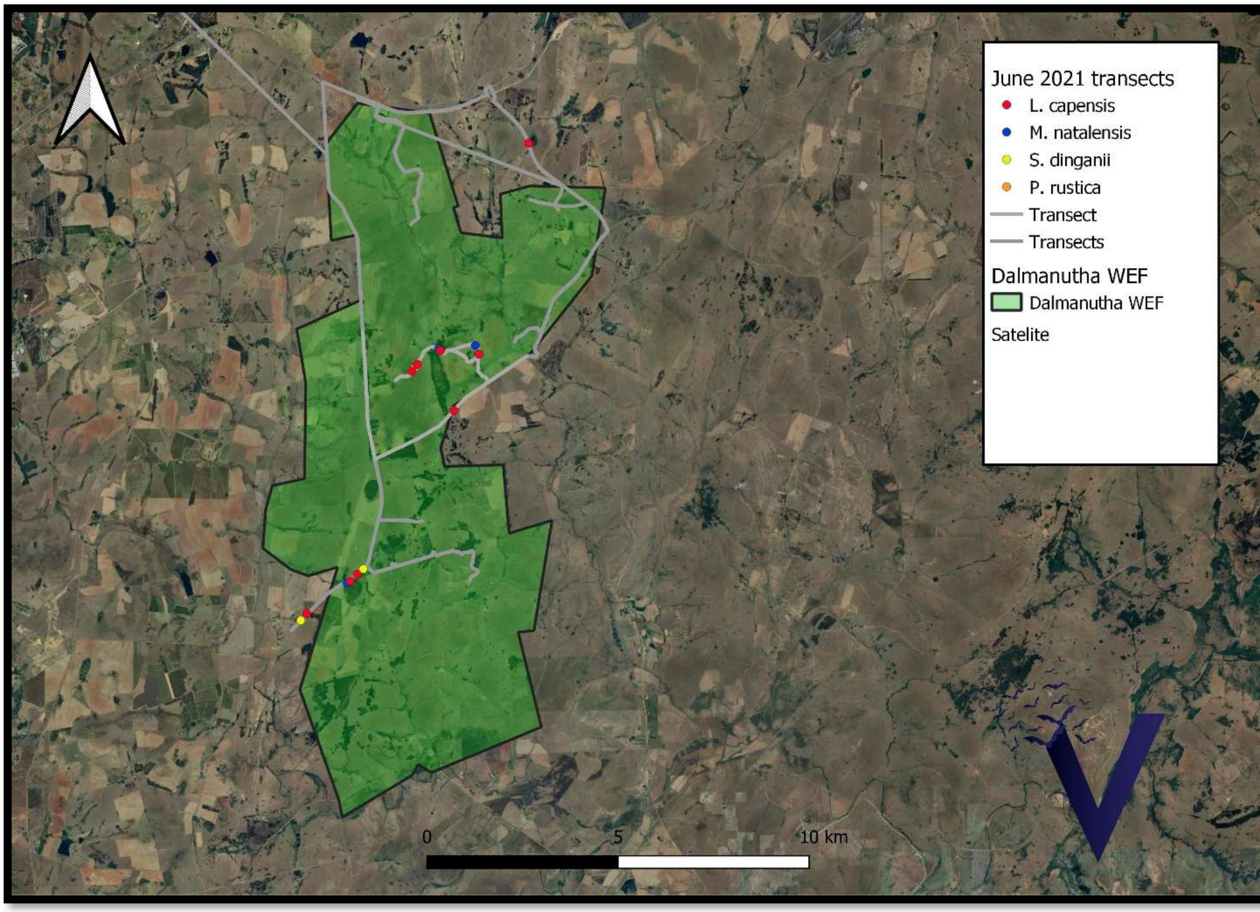


Figure 27. Locations of bat calls recorded during active monitoring in June 2021

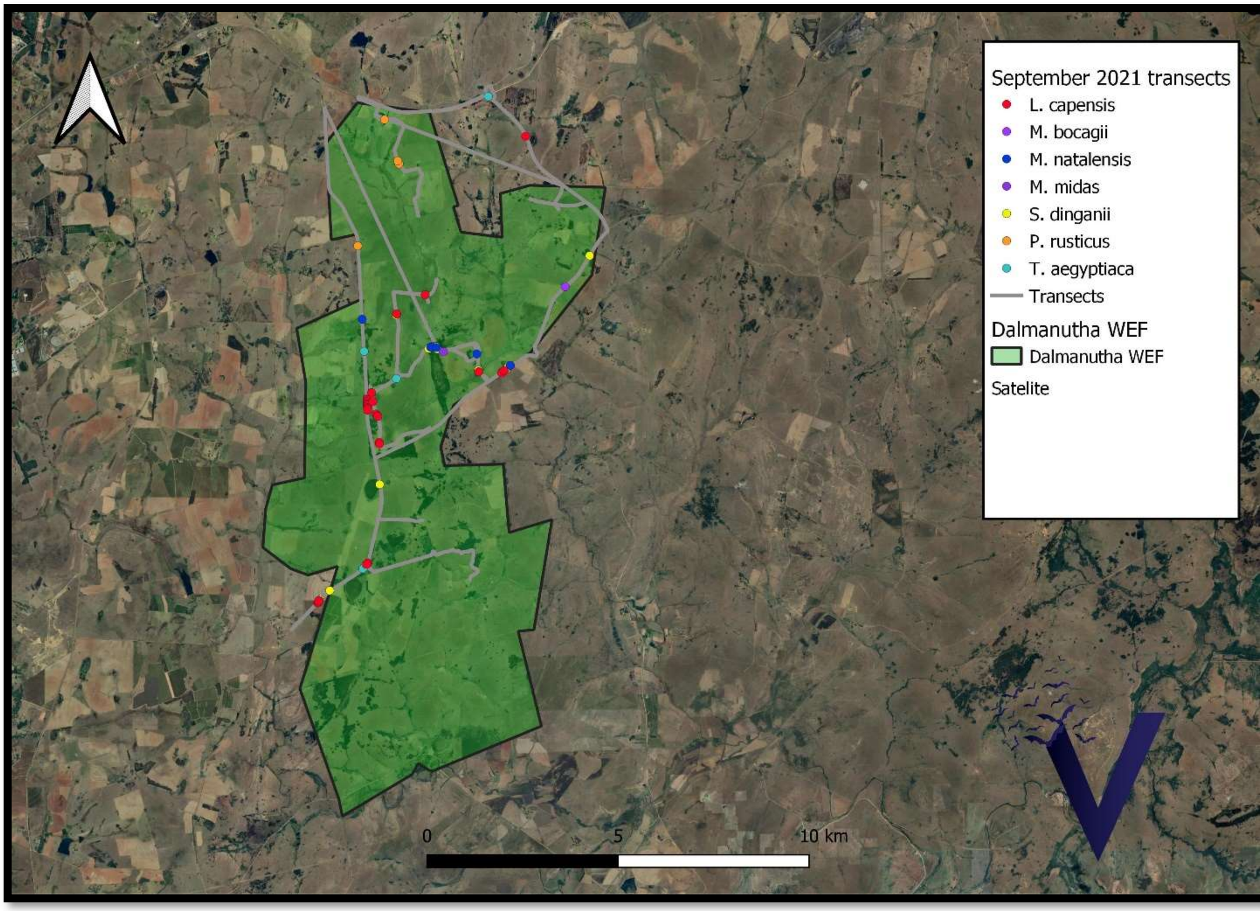


Figure 28. Locations of bat calls recorded during active monitoring in September 2021

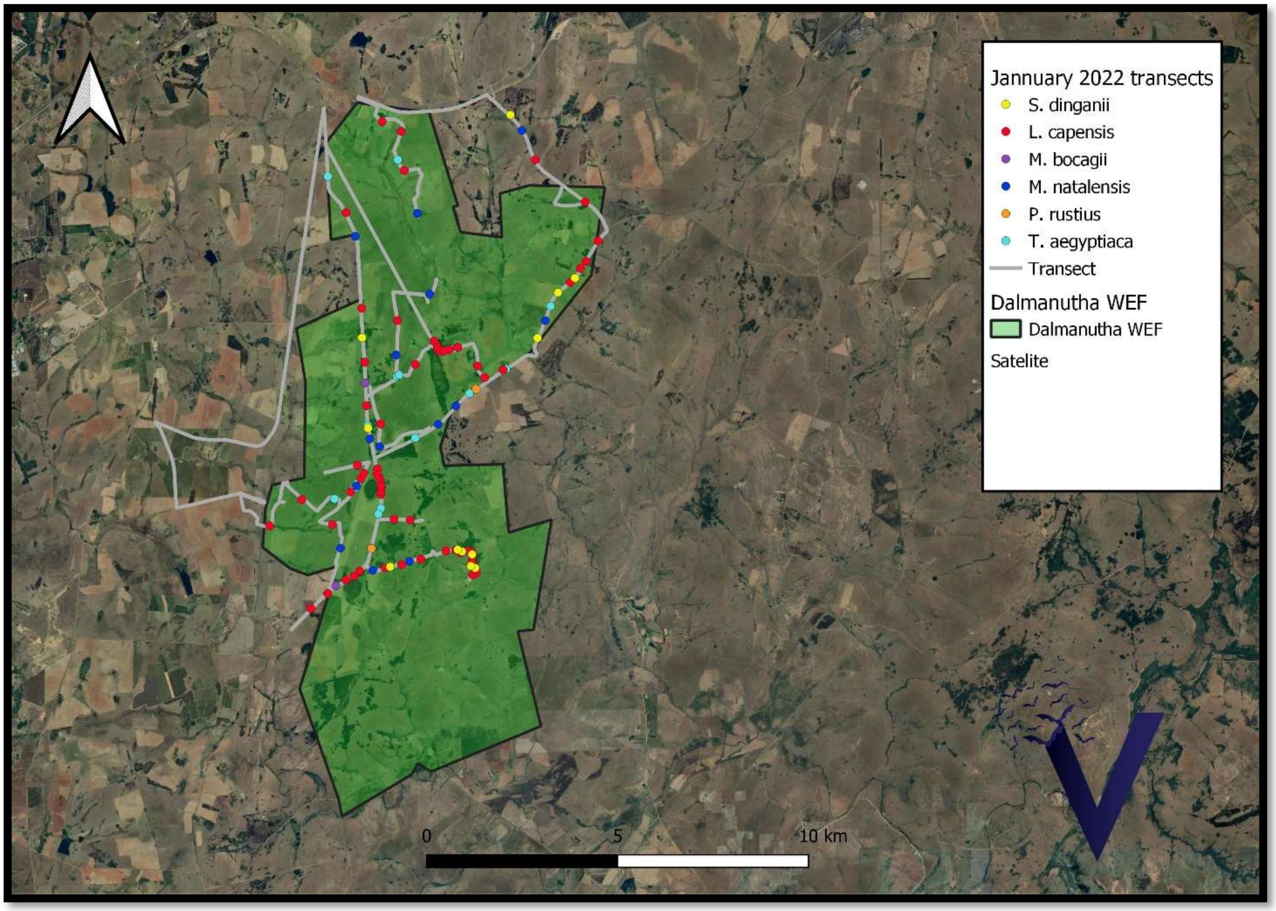


Figure 29. Locations of bat calls recorded during active monitoring in January 2022

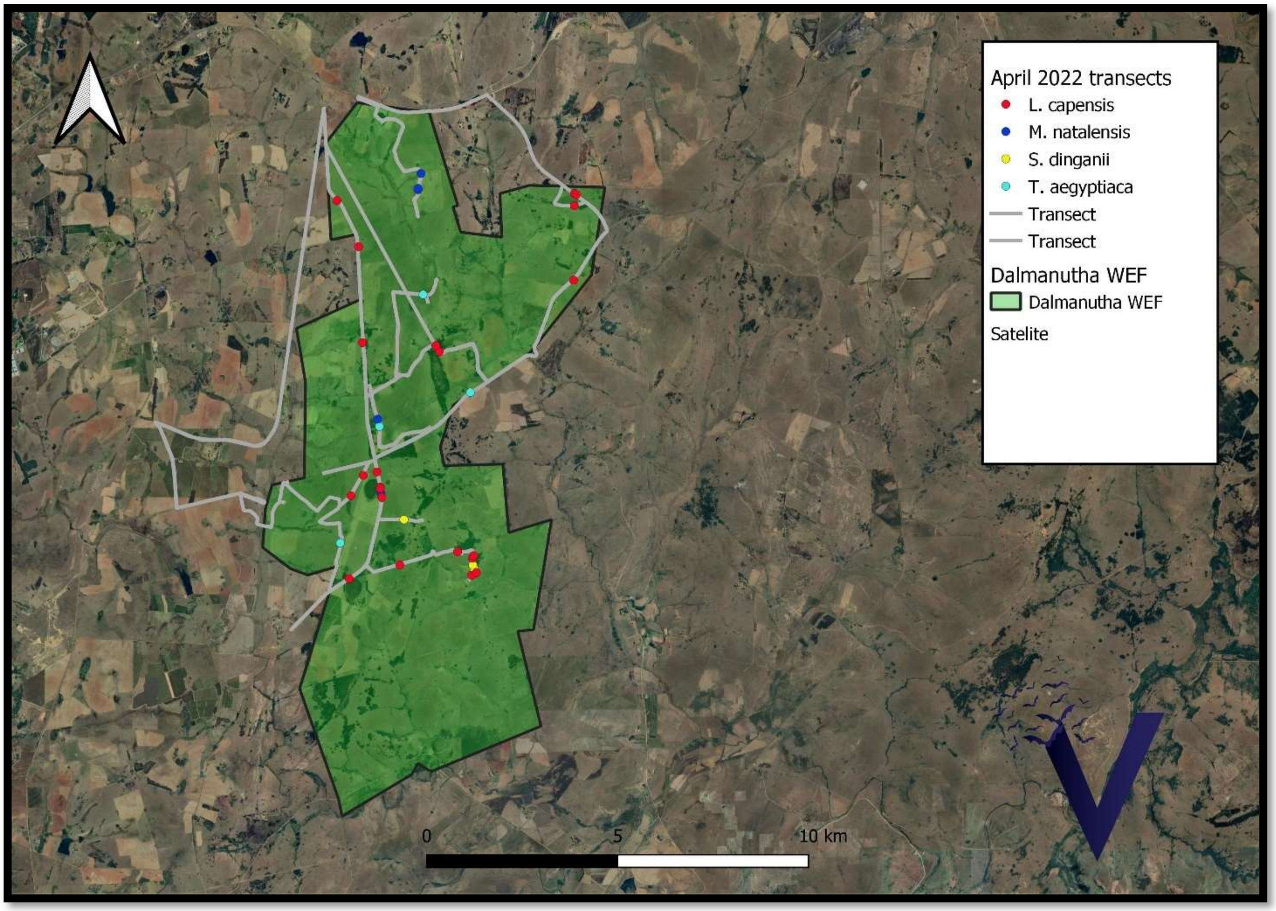


Figure 30. Locations of bat calls recorded during active monitoring in April 2022

3.6 Roost inspections

All potential roosts were inspected for signs of bats during the winter and summer survey periods, including large trees, any significant rock formations and buildings. Three confirmed *L. capensis* roosts were located on the PAOI, all within occupied houses (Figure 32). It is suspected that this large roost is shared between *L. capensis* and *S. dinganii* based on data collected during driven transects and by DAL 4, but we did not record calls from *S. dinganii* during roost surveys. More potential roosts were identified across the PAOI, but we could not confirm the presence of bats at any of these locations. A thorough investigation into the mining activities close to the PAOI was also conducted. Although old mine shafts have been shown to provide suitable roosting habitats, most of the neighbouring mine activities make use of open cast mining (Miller-Butterworth et al., 2003; Pretorius et al., 2020). There were no reports of active bat roosts at these mining facilities, but this does not exclude them as potential roosting locations as migrating bats may make use of them during specific months of the year.

No caves were found within the boundaries of the PAOI, and there are no known caves present within 20 km of any sites. The landowners were asked about caves on their properties, but they were not aware of any.

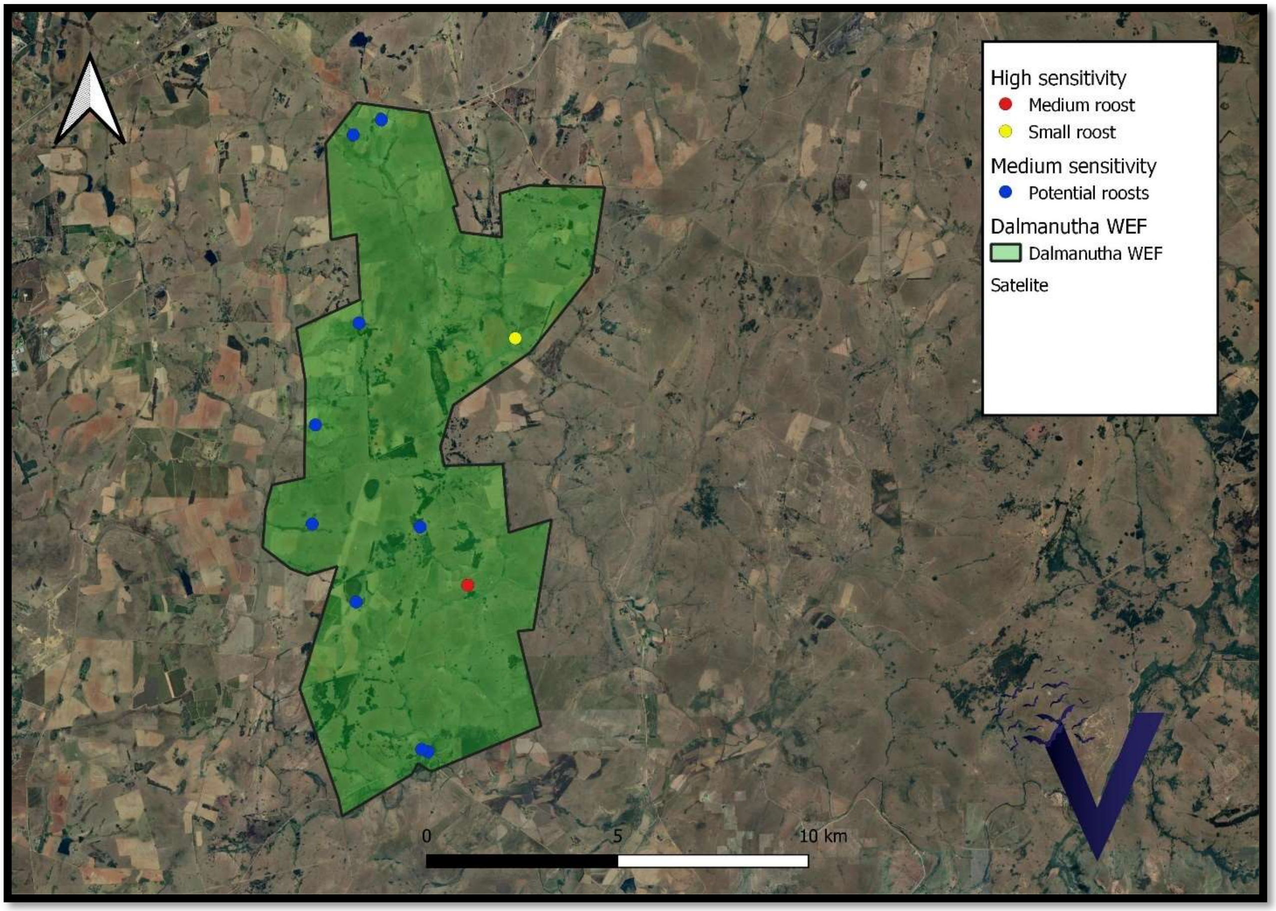


Figure 31. Potential and confirmed roosts found on the Project area of Influence.

3.7 Bat sensitive zones

Several potential bat sensitive areas, including water sources and potential foraging areas, are outlined below. A 200 m buffer was implemented around sites that are considered to be of Medium Sensitivity to bats as recommended by MacEwan (2022).

3.7.1 Water sources and foraging areas

Bats are heavily reliant on sources of open water and will visit at least one such source during the course of a night. Numerous sources of open water and one stream that runs through the eastern section of the PAOI was found (Figure 34). Based on data obtained from DAL 2 it is quite clear that water sources are important to bats, both as a source of water and a foraging area, and should be considered as a Medium Sensitivity area, and a 200 m buffer should be applied around them.
While there are many patches of large exotic trees found across the PAOI these have been deemed to be of lesser importance to bats considering data obtained from DAL 3 (Figure 36). As such no buffers have been implemented around these trees. All trees were also inspected during roost surveys for bats but no roosts were found.

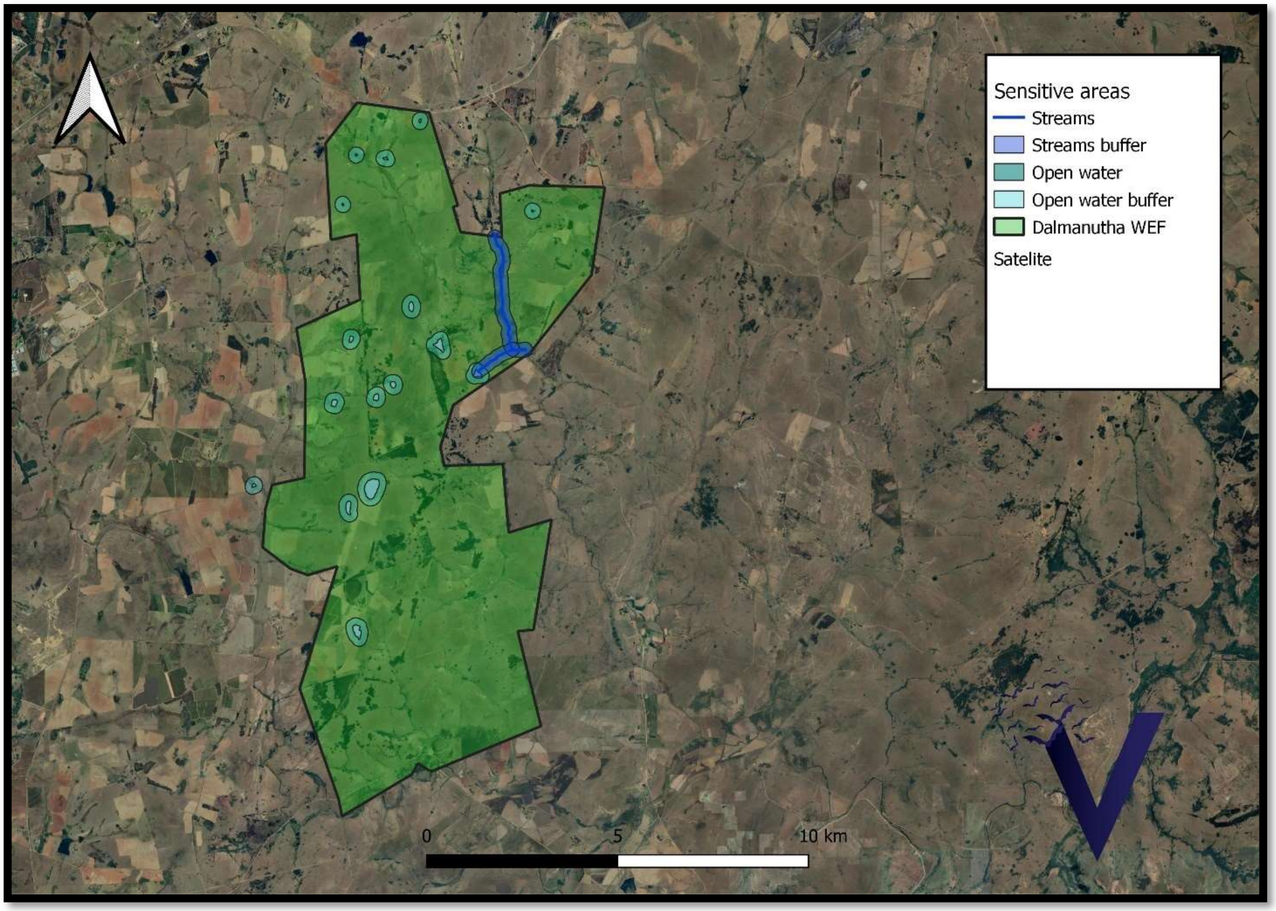


Figure 32. Locations of water sources on the Project Area of Influence, with 200m buffers included

Figure 33. Examples of potential roosts with evidence of bats on the right

Figure 34. Examples of larger trees on the Project area of Influence

3.7.2 Bat roosts

Two confirmed bat roosts were found on the PAOI, one small (1-49 bats) and one large (50-499 bats). Both were occupied by *L. capensis*, a bat that is of high risk of collision. As such a 1 km must be implemented around the small roost and a 2 km buffer around the large roost based on the SABPG (MacEwan et al 2020)

Figure 35. Bat roosts found on the Project Area of Influence with buffers.

4. Proposed layout and buffer zones

During our survey of bats in the area, we identified regions on the proposed site for the WEF that are currently classified as High Sensitivity and Medium Sensitivity Zones based on foraging areas, potential and active roosts, and availability of water (Figure 37).

All confirmed roosts and their associated buffers must be considered as High Sensitive, and thus No-Go areas for turbines and no part of the turbines should cross the buffers implemented around these locations. For Dalmanutha WEF Alternative 1 there are nine turbines that are located within these buffered zones (Figure 36). For Dalmanutha WEF Alternative 2 there are three turbines that are located within these buffered zones, and a further three that are potentially too close to the boundary of the medium size roost located in the southern section of the property (Figure 37). The planned solar facility will have no impact on any bat sensitive areas.

All water sources, including open water and streams, are considered as Medium Sensitive and a 200 m buffer has been placed around these areas. There are, however, no turbines in these areas. Potential roosts have also been marked, and a 500 m buffer suggested around these. These roosts may be used by bats from time to time, and it thus important that these are avoided. There are, however, no turbines in these areas.

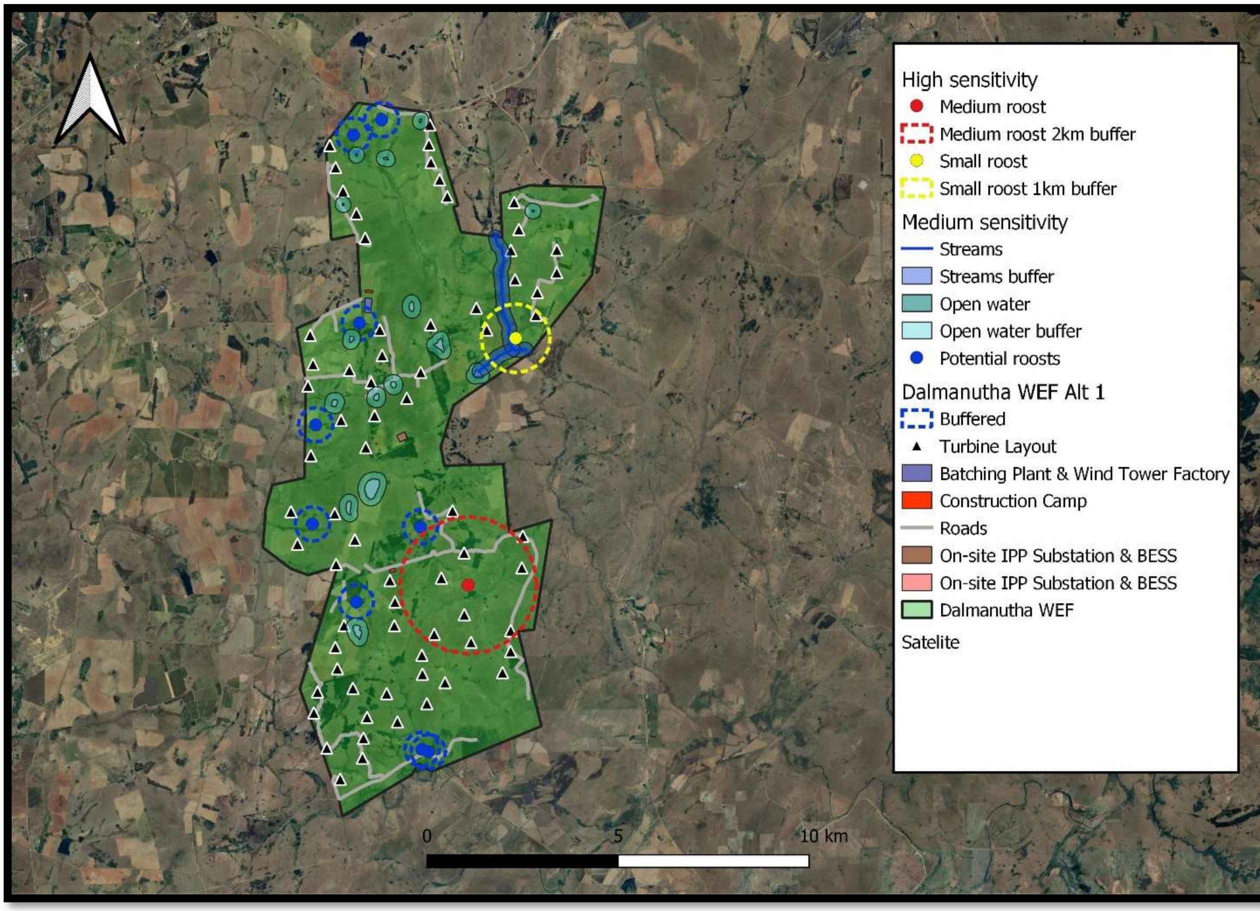


Figure 36. Suggested Wind Turbine Layout for Dalmanutha WEF alternative 2 with suggested buffer zones.

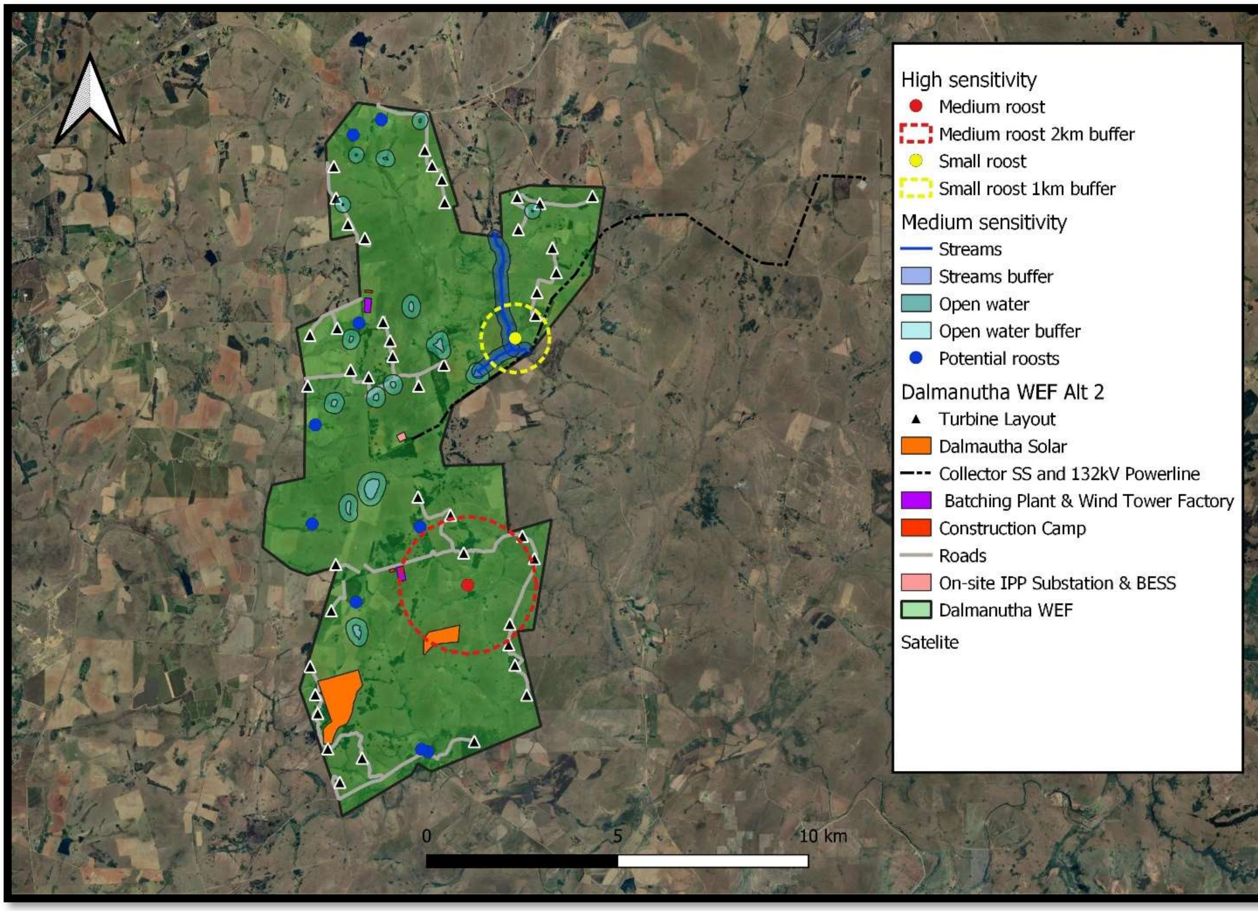


Figure 37. Suggested Wind Turbine Layout for Dalmanutha WEF alternative 2 with suggested buffer zones.

Based on the SABPG (MacEwan et al., 2020) no roads may be constructed within 200 m of any bat roost or foraging area, and powerlines may not be constructed within 500 m of any bat roost. All buildings and infrastructure may not be located within 500 m from any bat roost.

There is currently no overlap between confirmed roosts and any infrastructure, roads or powerlines (Figure 38). The proposed road in the south of the PAOI crossed between two potential roosts, and it is suggested that this road is moved as to not overlap with the 200 m buffer around these roosts if possible. All other roads are outside of the 200 m buffer around potential roosts and should thus not have an impact. The proposed road also runs along two water sources in the middle of the PAOI, but these are relatively small and it is not anticipated that it will have an impact.

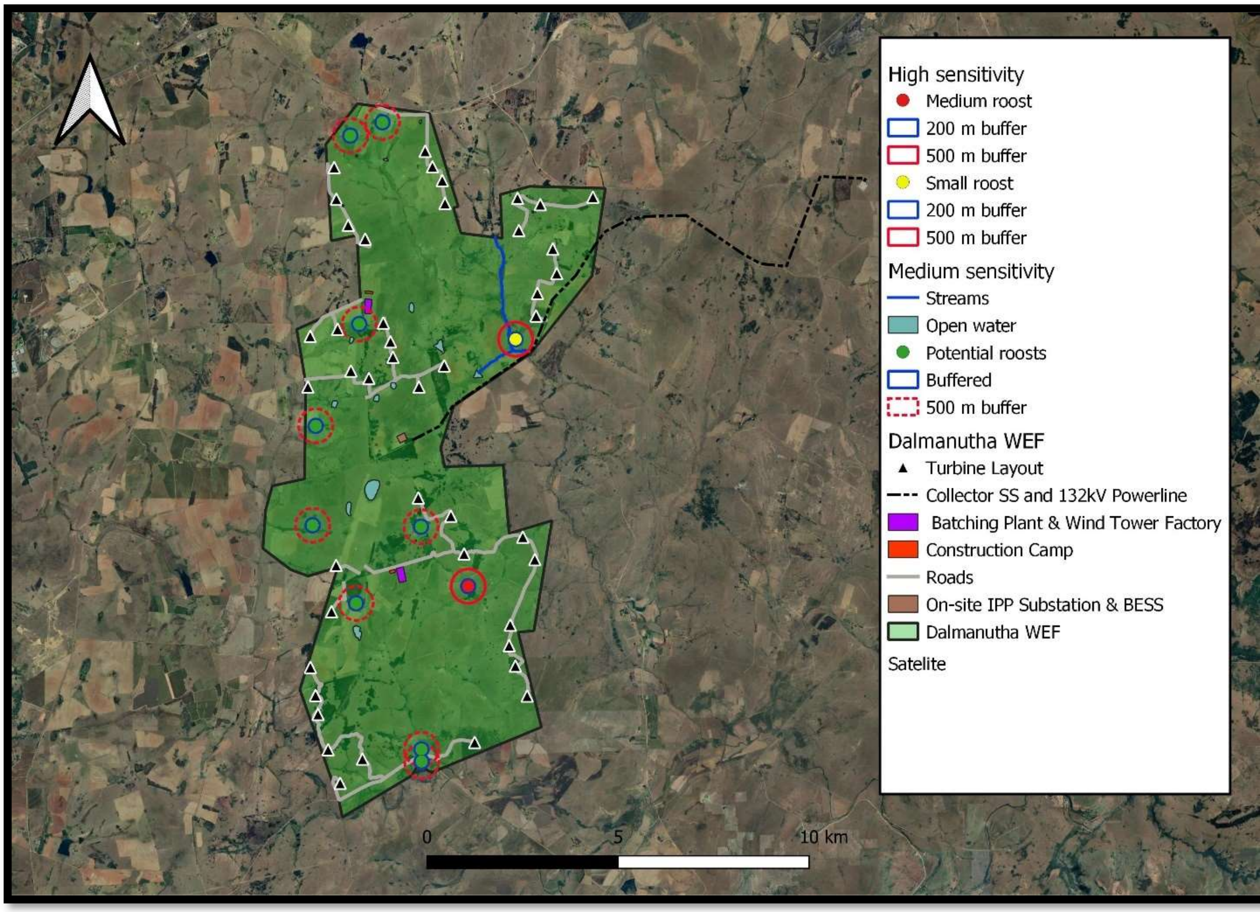


Figure 38. Roads, powerlines and infrastructure and their overlap with bat sensitive zones

5. Potential impacts

5.1 Impacts identified

Construction Phase:

- Habitat destruction: The construction access roads, turbine or infrastructure may lead to foraging habitat and sensitive bat features being removed (Table 9)
- Destruction or disturbance of bat roosts: The construction access roads, turbine or infrastructure may lead to bat roosts being disturbed removed (Table 9)

Operational Phase:

- Bat mortality: Bats killed due to barometric trauma or being struck by blades of the turbines during the operational phase. (Table 10)
- Artificial lighting: Artificial lights can have a negative effect on bat behaviour by affecting flight paths used or attracting them to lights due to higher insect abundance and elevating the likelihood of collision mortality. (Table 11)
- Habitat destruction: The construction access roads, turbine or infrastructure may lead to foraging habitat and sensitive bat features being removed (Table 9)

5.2 Cumulative impacts

There are currently no operational renewable energy facilities within 50 km of the proposed Dalmanutha WEF, but there are three facilities that have been approved (Figure 39). Two of these are solar facilities (Machadodorp PV 1 solar energy facility and Eskom Arnot PV Facility), but no data on the occurrence of bats or their abundance is available as bat monitoring is not a requirement for SEFs. The third facility is the Haverfontein WEF located 9 km south of the Dalmanutha WEF. A Sensitivity Assessment confirmed the presence of *L. capensis* and *T. aegyptiaca* on site, but no data is currently available on bat activity across a 12-month period for this site.

The Assessment determined that the Construction Phase should have a Low Impact on bats due to habitat and roost destruction. While mortalities could occur due to barometric trauma or collision, it was stated to be a Low Impact after mitigation. During periods of migration, however, there could still be a Medium Impact even after mitigation measures.

There is little data available on the cumulative impact that WEFs may have on bat populations, and this is largely due to data obtained from other WEF not being readily available. This said, it is not expected that the nearby Haverfontein WEF should result in a fatal flaw for the Dalmanutha WEF. Few roosts were found on Haverfontein WEF, and it is thus expected that the bat abundance, and subsequent activity, should be relatively low.

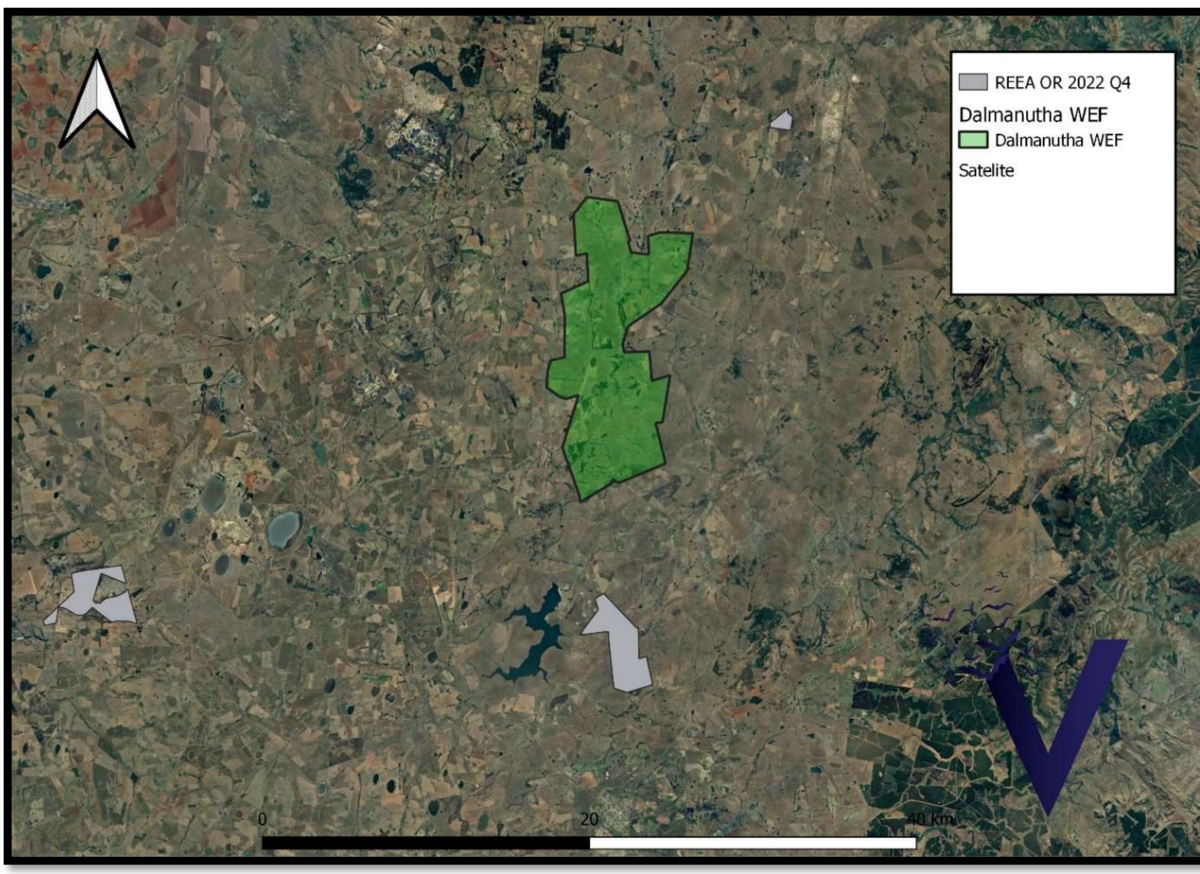


Figure 39. Location of renewable energy facilities near the Project Area of Influence

5.3 Impact assessment

5.3.1 Habitat and roost destruction

Due to the construction of roads, turbines and infrastructure it expected that a certain amount of habitat destruction will occur. The most sensitive habitat features for bats in the area appears to be sources of open water, and these must be avoided at all costs. In addition, the confirmed roosts must be avoided, and the buffers suggested above seen as NO-GO areas. While there are patches of trees in the area, these are all exotics and pose a risk to the surrounding grasslands. In addition, based on data obtained from our bat detectors, it does not appear that these trees are utilised by bats to a great extent.

Currently there are very little planned construction for both Alternative 1 and Alternative 2 near these sensitive features, and thus the impact without mitigation is expected to be Low. However, there are planned construction close to potential roosts and water sources. If these are moved outside of the buffered areas the impact is expected to be Very Low

Table 9. Impact on bats during the construction phase due to habitat destruction

	Impact Magnitude	Rating	Impact Extent	Rating	Impact Reversibility	Rating
Without mitigation	Low	2	Site	1	Recoverable	3
With mitigation	Very Low	1	Site	1	Recoverable	3
	Impact Duration		Rating	Probability of Occurrence		Rating
Without mitigation	5 – 10 years		3	Low Probability		2
With mitigation	5 – 10 years		3	Improbable		1
	Significance Rating of Impacts			Timing		
Without mitigation	18 Low			Construction phase		
With mitigation	9 Very Low			Construction phase		
Mitigation measures • Construction of new roads should be 200 m away from any water sources where possible. • Construction of new roads should be 200 m away from any potential roosts where possible.						

5.3.2 Impact due to bat mortalities

The overall median number of bat passes per hour was 0,27 BP/H at ground level and 0,00 BP/H in the rotor sweep zone. The SABPG states that between 0,23 and 1,76 bat passes per hour in the grassland biome should be considered as **Medium Risk** for bats. This area is thus classified as medium risk but falls on the lower end of this scale. While no specific migratory pathways were found there is a large influx of bats during specific times of the year, and the overall number of bat passes per hour increases drastically. During these periods the Impact Magnitude could be High to very High and have a long-lasting effect on the bat population. However, if the No-Go areas and necessary buffers are implemented and respected, and mitigation measures and adaptive mitigation measures applied, the impact on bats due to collision or barotrauma can be greatly reduced for both Alternative 1 and Alternative 2 of the proposed Dalmanutha WEF.

Table 10. Impacts on bats due to mortalities

	Impact Magnitude	Rating	Impact Extent	Rating	Impact Reversibility	Rating
Without mitigation	High	4	National	4	Irreversible	5
With mitigation	Low	2	National	4	Irreversible	5
	Impact Duration		Rating	Probability of Occurrence		Rating
Without mitigation	5 – 10 years		3	Highly probable		4
With mitigation	5 – 10 years		3	Low probability		2
	Significance Rating of Impacts			Timing		
Without mitigation	64 High			Operational phase		
With mitigation	28 Low			Operational phase		
Mitigation measures • No construction of turbines within buffered areas • Adaptive mitigation during operational phase						

5.3.3 Impact due to artificial lighting

Artificial lights can have a negative effect on bat behaviour by affecting foraging activity and flight paths used. Artificial lights can attract insects which will entice bats to feed in the area leading to a higher likelihood of bat fatalities due to collision with infrastructure or barotrauma (if lighting is present at the turbines). This impact could be high, but is easily reduced if low intensity, directional lights, and only minimal compulsory civil aviation lighting is used. Furthermore, non-UV emitting lights must be used. This should be applicable to all areas, but especially bat sensitive features used for foraging, such as any waterbodies. In certain areas the use of artificial lights will be unavoidable, and these include areas where offices, substations or operational and maintenance buildings will be constructed.

Table 11. Impacts on bats from artificial lights

	Impact Magnitude	Rating	Impact Extent	Rating	Impact Reversibility	Rating
Without mitigation	Medium	3	Site only	1	Irreversible	5
With mitigation	Very low	1	Site only	1	Irreversible	5
	Impact Duration		Rating	Probability of Occurrence		Rating
Without mitigation	Project life		4	Highly probable		4
With mitigation	Project life		4	Low probability		2
	Significance Rating of Impacts			Timing		
Without mitigation	52 Moderate			Operational phase		
With mitigation	22 Low			Operational phase		
Mitigation measures • Use only minimal compulsory civil aviation lighting						

5.3 Environmental management plan

All proposed buffers must be respected, and No-Go areas avoided. There are currently turbines planed in No-Go areas, specifically those around the confirmed large roost and some amendments may be required. Construction of roads may need to be reconsidered to avoid potential roosts and waterbodies and artificial light should be kept to a minimum.

As it has been shown that higher cut in speeds reduces the number of bat fatalities (Amorim et al 2012), and this will be required during times of peak activity (October to January). However, it would be possible to limit this to specific times of higher bat activity (18:00 – 21:00). Only once bat carcass and acoustic data collected during operational monitoring indicates acceptable fatalities rates can these suggested mitigation measures be relaxed, if appropriate.

The annual threshold for bat fatalities in this the ecoregion is 0,20 bats per 10 ha (MacEwan et al., 2018), and therefore a total of 184 bat deaths per year would be acceptable based on the guidelines. Considering that no priority species were detected, this is not expected to be a fatal flaw, but as fruit bats are often not detected because they do not echolocate, this must be considered during Post-Construction Monitoring. Adaptive mitigation is preferred, as fatalities can be prevented, but this requires rapid dissemination of the number of carcasses detected so that on-the-fly mitigation can occur.

6. Conclusion

Data presented here is based on a full 12-month monitoring period between June 2021 and June 2022. Even though detectors were down due to battery failure and lost SD cards, enough data was collected to accurately represent bat activity on the PAOI across this period.

A total of nine species were detected throughout the course of the year, with *L. capensis* being the most frequently recorded species. All other species were recorded to a lesser extent and with varying degrees of frequency. Although other species may occur in the area, we expect that it is unlikely that any priority species should be found.

As the area falls within the grassland ecoregion, the risk is classified as Medium based on the median of 0,27 bat passes per hour that we recorded. As we had a median of 0,00 bat passes per hour in the rotor sweep zone, this is classified as Low Risk (MacEwan et al., 2020). There are, however, large influxes of bats during specific times of the year, and during these times adaptive mitigation measures may be required. This will include increasing the cut in speeds of turbines to 4 m/s as this has been shown to reduce bat fatalities.

The largest concern for the proposed Dalmanutha WEF is the presence of three confirmed bat roosts, two small roosts and one large roost. The appropriate buffers have however been implemented around these roosts, and if these No-Go areas are respected it is expected that the resulting impact should be minimal.

In summary, the current location of the project area falls in a Medium Risk area for bat fatalities, and sporadic peaks of bat activity in late summer and autumn will require specific and targeted mitigation. A suitable cut-in speed should be implemented for all turbines that optimises energy production and reduces fatality. A higher cut-in speed must be implemented over the summer and autumn months from dawn to dusk and ongoing operational monitoring must inform adaptive mitigation measures, which includes curtailment as necessary. Solar facilities have very limited impact on bats, and as such Alternative 2 would have a lower impact on bats in the area. Alternative 2 will make use of fewer turbines, and this will thus greatly reduce the impact on bats. As such, it is strongly recommended that the layout of Dalmanutha WEF Alternative 2 is followed.

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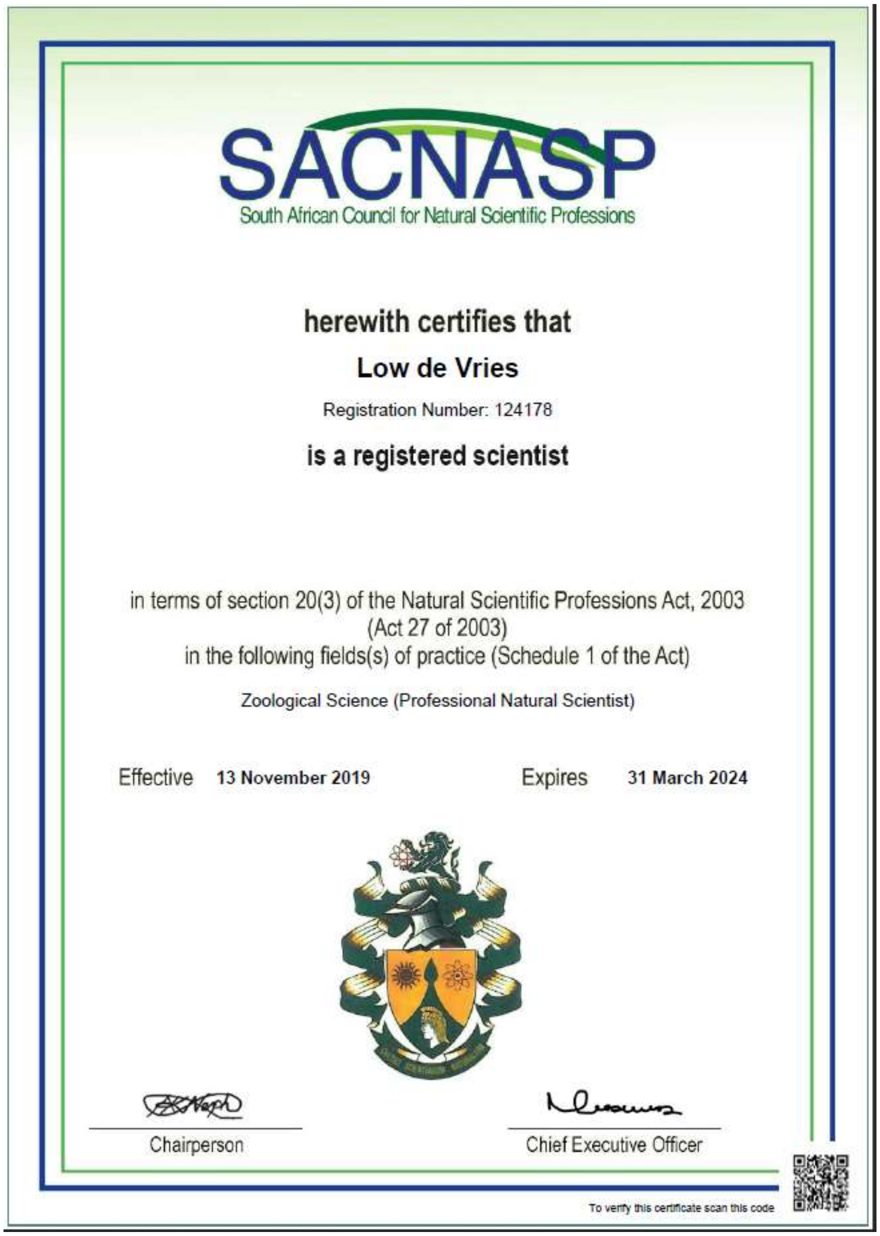
Appendix 1: Specialist qualifications



SACNASP
South African Council for Natural Scientific Professions

herewith certifies that

Low de Vries

Registration Number: 124178

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following fields(s) of practice (Schedule 1 of the Act)

Zoological Science (Professional Natural Scientist)

Effective **13 November 2019** Expires **31 March 2024**

Chairperson

Chief Executive Officer

To verify this certificate scan this code

04290887

University of Pretoria

The Council and Senate hereby declare that
at a congregation of the University the degree

Doctor of Philosophy
in
Zoology

with all the associated rights and privileges
was conferred on

John Low de Vries

in terms of the Higher Education Act, 1997 and the Statute of the University

On behalf of the Council and Senate

Vice-Chancellor and Principal

On behalf of the Faculty of
Natural and Agricultural Sciences

Dean (Acting)

Registrar

Ek sertifiseer dat hierdie 'n ware en juiste afskrif van die oorspronklike dokument is.
I certify that this is a true and correct copy of the original document.

Kommissaris van Ede / Commissioner of Oaths
van Zyl
Kliëntediens sentrum/ Client Service Centre
Universiteit van Pretoria/ University of Pretoria
Datum 18/06/2015 Date

2014-09-04

Appendix 2: Curriculum Vitae of bat specialist

Personal details

Full Name	John Low de Vries
DOB	7 November 1984
Nationality	South African
Marital Status	Married
Email	low@volantenvironmental.com
Phone	+27 82 323 5475
ID number	841107 5188087

Education

Completed	Degree and Institution
2002	Matric, Hoërskool Jeugland, Kempton Park, South Africa
2006	B. Sc Zoology, University of Pretoria, Pretoria, South Africa
2007	B. Sc (Hons) Zoology, University of Pretoria, Pretoria, South Africa
2014	PhD Zoology, University of Pretoria, Pretoria, South Africa

Key areas of expertise

- Bat Specialist — Conducting surveys on bat diversity and abundance and researh on bat ecology.
- Environmental Assessment Practitioner — Writing and collating Basic Assessment (BA) for proposed Wind Energy Facilities

Memberships & Certificates

- SACNASP Registered Professional Natural Scientist in the field of Zoological Science - Registration Number: 124178
- Bat Assessment Specialist with South African Bat Assessment Association (SABAA)

Other Training

- Multivariate statistical modelling (Cape Town, South Africa)
- Bat handling and identification course (AfricanBats)
- Snake handling (Chameleon Village (South Africa)

- ArcGis online course
- First Aid level 2 (Johannesburg, South Africa)

Focal Experience relevant to current project

2022-current - Bat specialist for a wind energy facility and associated grid connection Free State, South Africa
2022-current - Bat specialist for a wind energy facility and associated grid connection near Doringbaai, Western Province, South Africa
2021 -current – Bat specialist for three wind energy facilities and associated grid connection near Dordrecht, Eastern Cape Province, South Africa
2021-current – Bat specialist for wind energy facility and associated grid connection near Belfast, Northern Cape Province, South Africa
2021-current – Bat specialist for wind energy facility and associated grid connection near Aggeneys, Northern Cape Province, South Africa
2021-current – Bat specialist for wind energy facility and associated grid connection near Pofadder, Northern Cape Province, South Africa
2020-2021– Bat specialist for wind energy facility and associated grid connection near Loeriesfontein, Northern Cape Province, South Africa
2020-2021 – Bat specialist for wind energy facility and associated grid connection near Gouda, Northern Cape Province, South Africa
2017 - Biodiversity survey of Bats in Gorongosa National Park, Mozambique
2016-current – Bat Ecologist for the Centre for Viral Zoonoses at the University of Pretoria

Publications

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Employment & work-related experiences

2020 - present	Director and founder of Volant Environmental
2016 - present	Postdoctoral fellow, University of Pretoria
2015 - 2016	Postdoctoral fellow, NZG
2014 - 2015	Marion Island field assistant, University of Pretoria
2013	Documentary presenter, Oxford Scientific Films
2010 - 2011	Wildlife Education Trainer, Enviro- Insight
2010 - 2011	Game Raning Lecturer, Damelin Centurion
2009 - 2018	Lecturer and tutor, University of Pretoria

Recent Project Experience

For further details please contact me directly under low@volantenvironmental.com

Time span	Nature of project	Capacity	Industry / Sector	Client / Developer	Country (Province)
2022	Thand Tau Bat Impact Assessment	Bat Specialist	Renewable Energy / Onshore Wind	Enertrag SA (Pty) Ltd	South Africa (Free State)
2022	Camden Bird Impact Assessment	Bird Specialist	Renewable Energy / Onshore Wind	EDF Renewables	South Africa (Mpumalanga)
2022	Castle Wind Energy walkthrough	Bat Specialist	Renewable Energy / Onshore Wind	Savannah Environmental	South Africa (Northern Cape)
2022	Doringbaai Wind Energy Facility	Bat Specialist	Renewable Energy / Onshore Wind	WKN-Windcurrent	South Africa (Western Cape)
2022	Aggeneys Bat Impact Assessment Review	Bat Specialist	Renewable Energy / Onshore Wind	Genesis Eco-Energy Developments (Pty) Ltd	South Africa (Northern Cape)
2021	Dordrecht Bat Impact Assessment	Bat Specialist	Renewable Energy / Onshore Wind	ACED (Pty) Ltd	South Africa (Eastern Cape)
2021	Indwe Bat Impact Assessment	Bat Specialist	Renewable Energy / Onshore Wind	ACED (Pty) Ltd	South Africa (Eastern Cape)
2021	Waschbank Bat Impact Assessment	Bat Specialist	Renewable Energy / Onshore Wind	ACED (Pty) Ltd	South Africa (Eastern Cape)
2021	Gorachouqua Bat Impact Assessment	Bat Specialist	Renewable Energy / Onshore Wind	Enertrag SA (Pty) Ltd	South Africa (Northern Cape)
2021	Khoemana Bat Impact Assessment	Bat Specialist	Renewable Energy / Onshore Wind	Enertrag SA (Pty) Ltd	South Africa (Northern Cape)
2021-2022	Dalmanutha Bat Impact Assessment	Bat Specialist	Renewable Energy / Onshore Wind	Enertrag SA (Pty) Ltd	South Africa (Mpumalanga)
2020-2021	Bergrivier Bat Impact Assessment	Bat Specialist	Renewable Energy / Onshore Wind	Genesis Eco-Energy Developments (Pty) Ltd	South Africa (Western Cape)
2020-2021	Botterblom Bat Impact Assessment	Bat Specialist	Renewable Energy / Onshore Wind	Genesis Eco-Energy	South Africa (Northern Cape)

				Developments (Pty) Ltd	
2012	Dangerous snake removal	Herpetologist	Mining (Coal)	Anadarko	Mocimboa da Paia, Mozambique